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Report of Cases of Phosphorus Necrosis

The Economic Aspects of Industrial Medicine

Medical Supervision in Factories

The Pharmacology of Heavy Metals

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ETHER POISONING IN THE MANUFACTURE OF SMOKELESS POWDER *

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AND

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THE SMOKELESS POWDER INDUSTRY †

SMOKELESS powder,‡ pyroxylin, pyro powder, is guncotton dehydrated and reduced to a colloid condition by means of ethyl alcohol and sulphuric ether and then pressed and cut into appropriate shapes. It is not powder at all but looks like chopped, dark brown or black macaroni, spaghetti, or vermicelli, according as it is intended for use in large or small ordnance. During the manufacture there is one stage, block breaking, at which strong fumes of ethyl alcohol are given off, and two stages, mixing and pressing, at which the fumes of ether are strong. Yet in spite of the fact that smokeless powder has been made in all civilized countries for many years and was manufactured on an enormous scale during the war, there is practically nothing in the literature about ether as an industrial poison. The report of the Chief Medical Inspector of Factories and Workshops for the year 1918 mentions it, but only to state that the women who were introduced into smokeless powder works in England during the war suffered so much more severely from ether fumes than the men that it was necessary to give up employing them and put men in their places.

In the course of an investigation of industrial poisons in the making of explosives, which the U. S. Bureau of Labor Statistics undertook in the spring of 1916 (*Bulletin of the U. S. Bureau of Labor Statistics No. 219*, pp. 54 and 72), nine factories making smokeless powder were visited and an attempt was made to discover how much, if any, damage to health resulted from the breathing of ether fumes. At that time only men were employed in smokeless powder manufacture. After our entrance into the war, when it became necessary to substitute women for men in many occupations, a second inspection of

* Received for publication Feb. 21, 1920.

† By Alice Hamilton.

‡ Smokeless powder is not classed as a high explosive, being a product of lower nitration, containing about 11.5 to 12.5 per cent. of nitrogen. The high explosive powders, known as mixed powders, of which cordite is the best known, are made from nitro-cotton of higher nitration containing up to 13.5 per cent. nitrogen. These are mixed with nitroglycerin and sometimes acetone and vaseline to form colloided strips. These powders are not soluble in ether alcohol.

these plants was made, because it so happened that since the work in the ether department was light and easy this department was the very one in which women's labor could best be used. By the spring of 1918 several hundred women were doing this work.

About this time the National Research Council decided to make some studies on the subject of munition poisons, and, among others, on the effect of long continued exposure to fumes of ether. A smokeless powder plant was selected in which conditions were as good as they could possibly be during summer weather, and a woman who had been the technician in charge of the clinical laboratory of the University of Wisconsin Hospital, Mrs. H. M. Fogo, was sent to the plant to take the clinical histories of the women in the ether department and to make routine examinations of blood and urine.* Mrs. Fogo remained at the plant during July and August, 1918. Her blood findings, which are described in Dr. Minot's section of this paper, were interesting and seemed to call for additional tests to check them up and to supplement them. The National Research Council planned to have this additional work carried on in the same plant and on the same individuals, but before the arrangements were completed the signing of the armistice put an end to the employment of women in this and other smokeless powder works. The manufacture was at once greatly curtailed and the only available subjects for such a study were a small force of men in another plant. These men were a selected group, retained because of their skill and experience, and their willingness to remain showed that they did not suffer much discomfort from the ether fumes. Shortly after the armistice two selected students from the Harvard Medical School went to this plant and studied the condition of these male workers. The results obtained from the two groups, women and men, are not really comparable for the women had been employed only a short time — less than half of them as long as six months — and were not selected, since the oversusceptible had not been dismissed. The men, on the other hand, were mostly old hands with probably either natural or acquired immunity. These differences must be borne in mind in considering the data given below as well as in considering Dr. Minot's report of the blood findings in the two groups.

The processes involved in the manufacture of smokeless powder may be briefly described as follows:

1. Centrifuging the wet guncotton to get rid of the water.
2. Dehydrating, by forcing denatured alcohol through the guncotton in a hydraulic press.
3. Breaking up with wooden hammers the block which comes from this press.
4. Mixing the fragments with the solvent, ether alcohol.
5. Pressing the colloided product into a block.
6. Forcing the block through dies from which emerge long, perforated strings of different diameters.
7. Passing the strings through openings in a cutting machine to be cut into the required lengths.

After this, the so-called powder goes to the solvent recovery house where the ether is evaporated off and collected for further use, and then to the blending towers, but neither of these departments concerns us as they do not expose the workmen to fumes.

The processes described above are carried on usually in separate buildings and there is a high standard of cleanliness, necessitated by the explosive character of the dust. The problem of ventilation is rather difficult. Both alcohol and ether being inflammable in vapor form, great precautions must be taken to prevent overcharging of the air with vapors. In the block-breaking department where alcohol

* This investigation was made possible through the courtesy of the E. I. du Pont de Nemours Company, for whose assistance and co-operation the Committee on Munition Poisons of the National Research Council desires to express its gratitude.

fumes are given off it is easy to prevent an excess of fumes because the work is usually done in a small separate building with a wide window and door, yet it is not rare to find cases of at least slight alcoholic intoxication among the men who do this work. The mixing with ether alcohol is carried on in bread-kneading machines, usually in a long narrow building with a wide door in front of each machine and a window behind. The ether and alcohol are run in from a hose and then the machines are tightly closed during mixing but must be thrown open at the end when the men dig out the mixed cotton. During this time the air gets very heavy with ether, and in order to get at the last part of the charge the workman has to lean far over with his head inside the opening. To the observer this work seems to be attended with exposure to very unpleasantly strong ether fumes, but this exposure is not continuous and it is the unanimous testimony of workmen, superintendents, and company physicians that the amount of ether poisoning is insignificant in this department compared with the next, the pressing and cutting department. Eight times as much of the solvent is said to be lost in pressing and cutting as is lost in mixing.

The cotton and solvent from the mixing machine goes to a block press — " preliminary block " — and comes out a colloid mass, looking like crude rubber. This is pressed through a " strainer," a series of metal screens to remove impurities, out of which it emerges in long strings. These are pressed into the " final block " and the block is driven through a die precisely as is the dough for macaroni and spaghetti, and in the same way cords are formed of a thickness varying from that of coarse macaroni to the finest vermicelli, all perforated with tiny canals running the length of the string. The strings fall into fiber pails which are carried to the cutting machines in the same room, and each string is passed into an opening in the latter. It is here that very appreciable quantities of ether are given off and where the trouble from ether poisoning is greatest.

The pressing and cutting department cannot always be freely ventilated, as can the mixing, because the temperature must always be maintained at about 75°F. and therefore the windows can be wide open only in warm weather. Since ether fumes are heavy, the method of ventilation adopted is the delivery of heated air through pipes near the ceiling and the provision of vents at the floor level. I never saw suction applied to these vents and the ventilation was never good on hot and humid days in summer or in cold weather. It was only when my visit was paid on a fresh day in fall or spring, when the difference between indoor and outdoor temperature was just right, that I found the air in a pressing and cutting department quite tolerable. The men themselves always say that ether poisoning is worst in winter when all the windows are shut, and next on heavy, windless nights in summer.

Ether is expensive and the more progressive manufacturers made great efforts during the war to prevent its loss but with little success until late in the summer of 1918, when a method was devised for collecting the vapors from the bottom of the receptacle into which the strings of powder fall from the pressing machines. This was, however, too late to affect conditions in any plant but one.

The investigation made by the U. S. Bureau of Labor Statistics in 1916 disclosed the fact that acute ether intoxication was notorious among the men employed in the pressing and cutting departments, less so among the mixers. The ether departments were far from popular and there was a great labor turnover, especially in pressing and cutting, so that it was difficult to find men who had been at such work long enough to throw any light on the effect of

long-continued exposure to the fumes. To quote this report:

> New hands suffer a good deal from mild ether poisoning. They pass through all the stages of narcosis as they are known to the anesthetist, the gradually increasing confusion, excitement, which may make the man almost uncontrollable for a short time, then the gradual dulling of the senses and drowsiness, passing into stupor and unconsciousness. The physician, even if he be on the grounds, seldom sees the man in the stage of excitement; usually by the time he has reached the office he is already stupid. There is no treatment for this condition, beyond allowing him to sleep it off in fresh air. Occasionally cases are sent to hospitals, if the narcosis is unduly prolonged, and we have the record of one case in which unconsciousness lasted for twenty-four hours. There may be heart symptoms needing medical care, for a very rapid pulse is not uncommon.
>
> The two most serious cases of ether poisoning which came to our knowledge were lads who had recklessly exposed themselves to ether fumes for several hours. They had gone into one of the small buildings where ether is condensed from smokeless powder — "solvent-recovery houses," they are called — and had climbed up on one of the solvent-recovery bins where it was warm and comfortable. They lay down near a manhole which was supposedly well closed with a rubber gasket, but there must have been some escape of fumes, for after reading a while they both fell asleep. They were found after they had been there less than an hour and a half, and both were in an alarming condition — respiration only 6 or 8 a minute, pulse down to 30. Two hours' work with the pulmotor brought them around and they were apparently none the worse for their experience.
>
> The usual after-effects of ether anesthesia follow ether poisoning in industry. The next day the man is somewhat nauseated, has headache, cannot eat, is generally wretched, and has pains in his back. Often he becomes accustomed to the fumes and does not seem to be injured in any way by repeated exposures of many hours each day.
>
> On the other hand, there are men who cannot get used to it. The physician in charge of one of the largest smokeless powder works said that he had frequent requests for transfer from the ether men, but that he always convinced himself that the man was really ailing before he would accede to his request. The same morning he had just issued a transfer to a man who had symptoms of nephritis. This is not, in his opinion, a frequent sequel of long-continued exposure to ether fumes, but it may occur, and it would be a good thing if it were possible to make an examination of the urine of all men applying for work in this department.
>
> A case of chronic ether poisoning was reported by a physician practicing in the neighborhood of this same plant. The man had worked there for three months and was then suffering from albuminuria and puffed eyelids. He had never had these symptoms before.
>
> Another form of chronic ether poisoning affects the digestion and general nutrition chiefly. A man who had been in charge of smokeless powder works for six months gave his symptoms as follows: He lost his appetite, partly because he always had a taste of ether in his mouth. His breath smelt of it all the time. After about three months of this work he began to grow apathetic and listless. He felt tired out and was chronically constipated. He lost 20 pounds and decided to leave the place. After taking up other work he was still constipated for several months, but his appetite came back and gradually he regained his normal condition. Another man, a workman in the pressing and cutting room, had also had to leave on account of his health. He said he would feel at first very much exhilarated, "as if I were walking on air or had a million dollars," and then depression would come on, especially when he went home. He, too, found that his digestion and nutrition were seriously impaired.
>
> Most physicians and practically all superintendents and foremen believe that if a man can become accustomed to the ether so that he no longer gets a "jag," or only rarely, he will not be injured in any way by months or even years of such work. They point to the fact that some of the ether men actually gain in weight under the influence of the work.

The government report also speaks of the combined effect of alcohol and ether on smokeless powder men. The largest plants visited are situated directly across the Delaware from Wilmington in a prohibition territory, while Wilmington at that time was "wet." The powder men would often go over to Wilmington just after their work, would take a drink of whiskey or a glass or two of beer and almost at once become completely intoxicated, "dead drunk." Many of these men were taken to the workhouse and there they would scent the whole place with ether, their breath was so heavy with it. At first the magistrate was sceptical when told that the man who

had been found by the police dead drunk had only had a couple of glasses of beer, but later on it became generally accepted that such a condition was to be looked for in the powder men.

When the National Research Council took up the investigation of ether poisoning in smokeless powder manufacture in July, 1918, the work of pressing and cutting had passed in all the important plants into the hands of women and girls. In the factory selected for study, eighty to ninety women were employed during the summer months and came under the observation of the investigator. None of them had worked as long as one year. The majority had not worked six months. They were between the ages of 16 and 36, thirty-nine being under 21 years. Forty-seven had never done factory work before.

The work in pressing and cutting was light and easy with the single exception of lifting the 75-pound block into the pressing machine which was still done by men. The women took the strings from the pressers and passed them into the openings of the cutters. They worked in eight-hour shifts and as two shifts were omitted on Sunday, each woman had a full day's rest in seven and no one had to work a double shift when changing from day to night. They had many advantages as compared with the men who had preceded them; they were housed in excellent dormitories, if unmarried, or in the well-built company village, if married. The food furnished in the company restaurant was very good and even their recreation was carefully planned. The medical supervision provided was far more careful than that given to the men and the women were encouraged to go at once to the first-aid department if they experienced any real discomfort from the ether. In the two best plants it was customary to distribute hot coffee during the night shift, for it was on this shift especially that the women were likely to be overcome by the fumes. They were of a decidedly higher class than the men, some of them having gone into the work from patriotic motives. Another great advantage was their freedom from indulgence in alcohol.

The blood findings in this group of women are given later by Dr. Minot. Tests for the presence of sugar and albumin in the urine, which were made in fifty-five cases, gave negative results except for a slight trace of albumin in one and a more decided trace in two more. Two of these women were in perfect health, the third was suffering from symptoms of ill health which dated from her present employment. She had lost weight during her seven months of ether work, had lost appetite, suffered from nausea and occasional vomiting, was constipated, and felt drowsy while in the ether fumes.

Acute intoxication, "ether jag," had been experienced by forty-eight of the eighty women. Thirty-one had only one such attack, seventeen had had from two to many attacks. One girl had been overcome eight times in four months, another twelve times in six months. In addition, seventeen girls who never had a typical "jag" suffered more or less frequently from attacks of dizziness and faintness so that the number experiencing acute effects from the ether fumes was sixty-five, or 81 per cent.

The girls described their symptoms in different ways: "I felt sleepy and cross and wanted to fight some one"; "I felt very happy. I laughed and sang and wanted to keep on working, but they made me go out of doors"; "Sometimes I am happy and sing, sometimes I have to cry, and once I fainted away"; "I began to cry and I couldn't stop, so they took me to the hospital and there I was nauseated and sick for an hour, and for a week after I did not want to eat anything"; "I was dizzy and faint and when I tried to lift the powder I could not move my arms"; "I was

pushing a car along a runway and I kept getting drowsier all the time, then they brought the hot coffee around and I drank two cups and this drove away the drowsiness, but I became very much excited, and insisted on pushing the car the wrong way so that the foreman could not do anything with me, and had to get another girl and send me out of the building. Two girls fainted away that night."

Out of the group of eighty women, thirty-one made complaint of loss of health or of discomfort of some kind which seemed to be attributable to their exposure to the fumes of ether. One of the most common symptoms was loss of appetite, especially for lunch — they said they could not eat immediately after leaving the ether fumes. A few had at first eaten ravenously but this was soon succeeded by a distaste for food. Some of the girls said they would grow very thirsty while at work but dared not take a drink of water for it would bring on vomiting. Twenty complained of attacks of nausea and seven had actual vomiting. Faintness and dizziness were fairly frequent, thirty-five of the eighty making this complaint, although not all of these were suffering from real impairment of health; in some instances these were the only symptoms complained of. Constipation was brought on or increased by ether work in twenty-eight. Twenty-three said that they were losing weight. Drowsiness while at work was often troublesome and the girls on the night shift depended on strong coffee to keep them awake. Five had disturbed sleep but thirty-one slept more than ever before, some of them twelve, fourteen or even fifteen hours — practically all their spare time.

The following is a typical history:

D. S. is twenty-one years old and worked in a factory before coming here. She has been working in smokeless powder for nine months and is troubled with sick headache and a feeling of faintness most of the time, pain in her chest, and burning in the throat. About three times a week she has an attack of weakness, dizziness, faintness, nausea and depression, which is worse when she is on the night shift. She has no appetite, never touches her lunch and has lost sixteen pounds. She is too nervous to sleep well, averaging only four or five hours a night. Her cheeks used to be rosy but now her face is sallow and sometimes covered with a red rash.

This last symptom was mentioned by several of the girls. It seemed to be an itching eruption on the face, caused by the ether fumes, for it sometimes appeared only on the side of the face which was nearest to the cutting machine. The holes in the cutting machine through which the strings of powder were passed were about at the level of the girl's eyes.

On the other hand, forty-nine girls insisted that they were quite as well as before, with the exception in some cases of an occasional attack of fainting or of an "ether jag"; nine were gaining weight and seventeen said their appetite was better than ever before. It was evident that the susceptibility to ether fumes varied very decidedly among these girls. When the histories of those longest employed were selected, they were found to fall into two groups of equal size, one consisting of women who were not at all inconvenienced by their work or who suffered nothing more serious than occasional dizziness and faintness on a hot day, and the other of women who were apparently losing health and strength as a consequence of their work. Of the thirty-two women who had done ether work for more than six months, sixteen belonged to the group of immunes, and sixteen to the susceptible group.

The second study, made after the armistice, included thirty-five men between the ages of 19 and 50, the majority of them between 27 and 37 years of age. A complete physical examination was made of these thirty-five men, and no positive findings were obtained which could be definitely referred to ether. However, in four men the liver was just palpable. In one of these men,

one who was recovering from mild acute poisoning, a large trace of albumin was found in the urine. The examinations for albumin and sugar were negative in the other workers and the urine sediment which was examined in several cases was found not abnormal. Blood pressures were within normal limits.

A much smaller proportion of the men than of the women in the former group had felt the acute effects of the ether. While forty-eight of the eighty women had been "etherized" only nine of the thirty-five men had experienced any acute discomfort of this kind, and four of these described it as only a slight exhilaration when the ether was strong, not severe enough to make them stop work.

Aside from symptoms which were referable to acute ether poisoning, certain other symptoms were elicited by questioning. Twelve men complained of increased thirst, definitely greater than when they were doing other work. Six complained of lassitude, five of palpitation of the heart, but usually only when the ether fumes were strong. Three said that they had specks before the eyes, four had a feeling of numbness in the fingers and one, numbness or burning in the feet. Eighteen had, so far as they knew, neither gained weight nor lost, but thirteen had lost from 5 to 25 pounds while engaged in this work. These men had been employed from ten months to seventeen years, only four of them for less than three years. On the other hand, four men who had worked, respectively, for two months, three years, five years and nine years claimed to have gained from 2 to 20 pounds in weight.

THE BLOOD OF INDIVIDUALS CHRONICALLY EXPOSED TO ETHER*

Preliminary observations on the blood of fifty-one individuals chronically exposed to sulphuric ether fumes were carried out by a qualified technician, Mrs. H. M. Fogo, under a grant from the National Research Council. The individuals examined were all young women between the ages of 16 and 30; over half were under 22 years of age. Analysis of the data obtained by Mrs. Fogo shows that in over half of the workers the number of red corpuscles was above 6,000,000 per c. mm., a figure distinctly above normal for women, who in general have lower red counts than men. The red counts obtained in these fifty-one individuals are summarized in Table 1. Mrs. Fogo made control counts of the red cells on healthy young women in the same locality as the ether workers. These control counts varied between 4,700,000 and 5,300,000 cells per c. mm.

The hemoglobin determinations on these ether workers were not entirely satisfactory but it may be stated that, on the whole, the hemoglobin averaged, relative to the red counts, distinctly low; namely, about 80 per cent.

TABLE 1. — RED COUNTS OF FIFTY-ONE WOMEN EXPOSED TO ETHER FUMES

Number of Cases	Red Counts in Millions
3	7.5 to 7.8
4	7.5 to 7.0
14	7.0 to 6.5
10	6.5 to 6.0
14	6.0 to 5.5
4	5.5 to 5.0
2	5.0 to 4.5

The white counts as a rule were above normal. They averaged 11,000 cells per c. mm., there being two cases with counts as high as 16,000 and two as low as 6,800. The white counts bore no definite relation to the level of the red counts. Detailed examination of the red cells, white cells and platelets, as well as other observations on the blood, were unfortunately not made in this series.

* By George R. Minot. From the Medical Clinic of the Massachusetts General Hospital and the Department of Medicine of the Harvard Medical School.

The symptoms which this group of young women exhibited have been referred to by Dr. Hamilton. From the data available, there appears to be no clear-cut relation between the red counts and the symptoms.

Because of the increased red counts in these women, a further examination of individuals constantly exposed to ether fumes was undertaken under the auspices of the National Research Council. This work was conducted under my guidance by two specially qualified medical students, J. B. Garland and Roy A. Wheeler. The thirty-five employees available for the study differed materially from those of the first series, in that, instead of being young girls, they were mature men averaging about 32 years of age. In the following sense, moreover, this group of men represented selected individuals. Shortly before the study was undertaken, a large cut had been made in the number of persons employed in the department of the factory where the exposures to ether occurred, so that the men who were examined had either volunteered their willingness to continue work or had been selected as particularly skilful. The majority of these men had been in work exposing them to ether fumes for over three years, while most of the women of the first series had been exposed to ether fumes for less than six months, and none for a year. The men had definitely fewer symptoms from ether than the women. This fact has been referred to by Dr. Hamilton.

TABLE 2.—RED COUNTS AND HEMOGLOBIN PERCENTAGES OF THIRTY-FIVE MEN EXPOSED TO ETHER FUMES

Number of Cases	Red Counts in Millions	Average Hemoglobin Percentages
2	6.5 to 6.7	76
5	*6.2 to 6.0	
5	6.0 to 5.5	88
17	5.5 to 5.0	82
6	5.0 to 4.6	76

* There are no cases with counts between 6.2 and 6.5.

The red counts and the hemoglobin percentages (Sahli)* of these thirty-five men are shown in Table 2. (More than one count was made on some cases; fluctuations occurred but none were great.) Detailed microscopic examinations † of the red cells showed that they were slightly but definitely abnormal in about 20 per cent. of the cases. Their abnormality consisted in the existence of some achromia and of slight but definite abnormal variation in size. Occasionally an abnormally shaped cell was seen, and rarely a polychromatophilic cell. No microcytes occurred nor were other abnormalities noted. The reticulated red cells occurred in normal numbers. There was a rather definite tendency, though exceptions occurred, for the cases with the higher and the lower red counts to show abnormality of the red cells, rather than for the individuals with red counts between the extremes. This is consistent with the fact that anemia, as determined by the diminished amount of hemoglobin per unit of blood, was particularly present in the cases with the highest and the lowest red counts.

The white counts in the thirty-five men averaged 9,500 cells per c. mm. There were six cases with counts between 12,000 and 16,000 and seven with counts between 5,000 and 7,000. There was no definite relationship between the white counts and the height of the red counts. Differential counts of the white cells showed the polynuclears between 70 and 80 per cent. in seven cases and between 48 and 54 per cent. in four cases. There was a rather definite tendency for the higher polynuclear counts to occur with the higher red

* In a series of twenty clinical cases, normal and anemic, in the wards of the Massachusetts General Hospital, the hemoglobins, as estimated by the same Sahli instrument, were 16 to 26 per cent. lower than when determined by Palmer's method. Normal controls with this same Sahli instrument showed a hemoglobin of 85 to 96 per cent.

† The blood preparations were all critically studied by myself but important assistance was given by Miss Margaret Weld in studying them.

counts. Slight increases of large mononuclear cells were seen in some instances.

The blood platelets, as estimated from the fixed smears, occurred in essentially normal numbers, the tendency, perhaps, being toward a very slight increase.

In general, the blood examinations of these men did not show any striking abnormality. The red counts alone could perhaps be considered merely as high normal figures, though it does seem unusual to find among thirty-five men seven who had red counts of over six million. Many of the red counts were certainly well above normal in the women workers, which suggests that the higher counts in the men were due to the same cause. One may explain the observation that the men showed fewer blood changes than the women on the ground that they had not been affected by the ether to the same degree — a probability supported by the fact that the women had decidedly more symptoms than the men. This may have occurred because the men were selected individuals less susceptible to ether, or perhaps because they had developed an immunity to ether, or possibly because they received less of the substance.

The various possible physiological mechanisms that may have caused this polycythemia will not be discussed. At the present time there is no definite evidence of the way in which constant exposure to ether produces a polycythemia. The polycythemia may be due to increased formation of blood, or it may occur from a mobilization of reservoirs of red cells. From the hemoglobin estimations and from the histological appearance of the red cells in some of the male workers, it seems that slight anemia occurred in some of these individuals. It is known that anemia may exist concurrently with increased counts of the red cells as has been observed in cases of polycythemia vera.

In both the male and the female series of cases, the white cells were increased above normal, though not definitely in relation to the red counts. This increase may have been partially dependent upon the same physiological process that produced polycythemia, but was probably due, in part at least, to the direct effect of ether itself. The simple slight anemia which existed may also have been a factor, since in anemia there usually occurs a compensatory increase of white cells from the marrow. The very slight platelet increase may be similarly accounted for.

Summarizing briefly, it may be said that some individuals chronically exposed to ether fumes show polycythemia, increased white counts and, at times, evidence of slight anemia.

REPORT OF CASES OF PHOSPHORUS NECROSIS*

THOMAS M. LEGGE, M.D., D.P.H.
His Majesty's Medical Inspector of Factories

SINCE the prohibition of the use of yellow phosphorus in the manufacture of matches, dating from 1910, no cases of phosphorus necrosis have been reported in Great Britain from that source. A series of such as had occurred between 1900 and 1905 was published in the Annual Report of the Chief Inspector of Factories for 1905. In the years 1914–1918, however, phossy jaw underwent recrudescence. During this time eleven cases were reported from one factory in which the manufacture of phosphorus is carried on. They are given in detail in Table 1.

Until these cases, an apparent immunity, extending over many years, had been enjoyed. Although the number of individual workers brought into contact with phosphorus for one and another war purpose has been considerable, only one case has been reported in processes other than the manufacture. With this exception, all had worked for years in phosphorus processes. In the factory in question, examination of the dental condition by a surgeon and reference by him to a dentist of those whom he considered needed treatment had been relied on in past years, instead of examination by a dentist in the first instance, which would, in my opinion, have been the wiser course. After the first case (which proved fatal) in 1914, the firm engaged the services of a dentist with the intention, since carried out, of putting the teeth of those coming into contact with phosphorus into a sound condition, and linking up the work of the dentist with that of a consulting surgeon of the highest standing in case of need. The dentist attends two afternoons a week in the well-equipped dental surgery on the works and quarterly examination of all the workers has been arranged for. This examination has led to the detection of the cases of necrosis, the presence of which was shown after the removal of the decayed teeth. Dealing with these cases Mr. Thomas (Walisall) reports as follows:

> With three exceptions all the cases reported as suffering from phosphorus poisoning have been employed in connection with the condenser plant. The condenser plant is situated at the back of the furnaces, and the whole is contained in one large, lofty building. Men employed in the phosphorus process can be divided into two sections — furnace men and condenser men. It is noteworthy that among the furnace men no cases have been reported. These men do not handle phosphorus but are subject to the pentoxide fumes of burning phosphorus when any slight leak occurs on the furnace. Although in the same building as the condensers, the fumes from the condenser side do not appear to reach these men to any extent. This is probably due to the heated air rising from the furnace acting as a kind of screen. A much larger number of men are employed in handling phosphorus and phosphorus mud on the condenser side.
>
> In emptying the condensers the crude phosphorus is syphoned off while in the molten state and run under water into cast iron moulds where it solidifies. After the phosphorus is drawn off, the residues, known as phosphorus mud, are also syphoned off and removed for further treatment.
>
> During the syphoning and subsequent handling of the crude phosphorus and mud, fumes consisting of the lower oxides of phosphorus arise and similar fumes come from the mud which has splashed on to the wet floor. It was hardly practicable to remove these fumes by exhaust ventilation as there were so many points of origin. The efforts of the firm were concentrated on improving the condensers and the drainage of floors. Concrete was largely used in place of wood for the condensers and the floors between condensers were relaid. This improved the conditions, as splashes of phosphorus or mud could easily be swilled away. In addition, the sides of the building were opened up, so as to obtain better general ventilation. With improved condensers im-

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TABLE 1. — REPORTED CASES OF PHOSPHORUS POISONING, 1915–1918

No.	Age	Sex	Precise Occupation to Which Poison was Attributed	Duration of Employment		Part Affected and Subsequent History	Severity	Duration of Illness	Report of Condition by Consulting Surgeon, January, 1919
				Factory	Phosphorus Process				
1	66	M	process man — on phosphorus condensers	many years	many years	Lower jaw. This man was pensioned off on Oct. 8, 1913. Died June 15, 1915.	fatal	Jan., 1914 to June 15, 1915	
2	44	M	process man — on phosphorus condensers	10 years	10 years	Left upper and right lower jaw. Operated on June 27, 1915. Certified as fit only for light work on Jan. 7, 1919.	severe	March 16, 1915 to present time	Both upper and lower jaws appear sound but there has been complaint recently of some discomfort on the left side of the superior maxilla. Directed to see the dentist again as to artificial teeth which he needs as his nutrition is suffering. He is getting thinner still and has lost weight, 2 stones altogether. Is fit only for light work.
3	47	M	process man — on phosphorus condensers	10 years	10 years	Right lower jaw. This man returned to work on Nov. 28, 1915 but was not employed amongst phosphorus. Now certified as fit for any work.	slight	April 23, 1915 to Nov. 28, 1915	Upper jaw is quite sound, the left side of lower jaw still rather sensitive; is not fit for artificial teeth for about six months, when he should see the dentist. May now do any work.
4	43	M	process man — on phosphorus condensers	6 years	6 years	Right lower jaw. This man returned to work Oct. 16, 1916 but was not employed amongst phosphorus.	moderate	Oct. 16, 1915 to Oct. 16, 1916	The jaw is sound but on the right side of the lower jaw the pressure of the dental plate is irritating and the plate cannot be used or some fresh trouble will be set up. He should see the dentist and if the present plate cannot be altered a new one should be provided. His nutrition is suffering and he is losing weight because of his inability to take ordinary food.
5	45	M	process man — on phosphorus condensers	23 years	23 years	Right upper jaw. This man returned to work Sept. 25, 1916 but was not employed amongst phosphorus. Now certified as fit for any work.	moderate	July 1, 1916 to Sept. 25, 1916	Both jaws are now sound and teeth are fixed without inflammation around them. May now do any work.
6	58	M	process man — on phosphorus condensers	many years	many years	Extensive necrosis in right upper jaw from tuberosity to incisor region — opening from mouth into antrum and nose; also small area in left upper premolar region. Now certified as fit for any work.	severe	June 5, 1917 to Sept. 4, 1918	Jaw is quite sound but the communication between mouth and antrum will be permanent. This is, however, protected by his upper denture. May now do any work.
7	23	M	soldering tins containing phosphorus	5 months	5 months	No necrosis. Phosphorus poisoning only: intense salivation.	severe		This man had been a sheet metal worker and was taken to solder up tins containing phosphorus owing to pressure of war work. He recovered and returned to his ordinary work.
8	26	M	process man — amorphous phosphorus	12 years	12 years	Extensive necrosis both sides of lower jaw from region of wisdom tooth to canine, right side, and premolar and molar region, left side. Returned to work Nov. 10, 1917 but was not employed amongst phosphorus. Now certified as fit for any work.	severe	June 2, 1917 to Nov. 10, 1917	The jaw is sound and the remaining teeth are sound but he needs dentures badly. May now do any work.
9	58	M	process man — on phosphorus condensers	2¾ years	2¾ years	Necrosis of lower jaw commencing about socket of lower left premolar, confined to external plate of alveolus and extending from region of left first molar to that of right premolars.	moderate	Dec. 3, 1917 to June 22, 1918	Is now quite sound with just a little numbness of the lower lip. The remaining teeth are sound but he is not wearing his artificial dentures which he should do. He may do any work.
10	28	M	process man — amorphous phosphorus	4 years	4 years	Left lower jaw from incisor region to first molar. Returned to work Aug. 18, 1918 but was not employed amongst phosphorus.	moderate	Nov. 1, 1917 to Aug. 18, 1918	
11	31	M	process man — on phosphorus condensers	4 years	4 years	Left side lower jaw. Is not fit yet to return to work.	severe	January, 1918 to present time	The jaw is healed but very sensitive still; some of the teeth are loose and the gum is rather inflamed. I should like this man to see the dentist. His general condition is unsatisfactory, and he is not yet fit for work.
12	47	M	process man — on phosphorus condensers	25 years	15 years	Right upper jaw region of first molar. Returned to work July 27, 1918 but was not employed amongst phosphorus.	severe	June, 1918 to July 27, 1918	

proved methods of working were introduced, so as to reduce the amount of handling and consequent exposure to air of the crude phosphorus and phosphorus mud. The amount of fume in the air became noticeably less, but there was still room for improvement. Further experiments were made which have proved that in the future it will be possible to draw off the phosphorus and phosphorus mud from the condensers in such a way that fumes can only escape at one or two points. These points of escape can easily be dealt with by means of exhaust ventilation.

Two cases of phosphorus poisoning occurred in the amorphous phosphorus department. In this department yellow phosphorus is converted into the amorphous or red variety. The amount of fume in this process is not great, and as the fumes are given off at definite points, they can be dealt with by means of exhaust ventilation. A satisfactory system of exhaust ventilation is now working.

THE ECONOMIC ASPECTS OF INDUSTRIAL MEDICINE*

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AS one first meets the conditions which govern the conduct of industrial medicine he is disturbed by them in direct proportion to the degree in which he has lived in the non-commercial aspects of medical life. With further experience the field discloses itself more fully, and it becomes possible to realize that there are two great reasons why medicine and industry do not meet as fairly as they should, without the relinquishment of anything by either side. The first of these reasons rests upon the fact that business knows nothing at all of the things medicine is now equipped to furnish; and the second, upon the fact that physicians know nothing whatsoever of the demands of productive business. There is a phrase which the employer uses very readily in relation to industrial medicine. He wants it "sold" to the employees. If his conception of selling means a fair return for both sides — and an honestly administered medical department in the hands of a well-trained and human physician can result in no other way — there can be no objection to the term; but if the medical department is designed to leave the profit all on one side, the physician may properly distrust the situation. Well-administered medical departments in industry rest, then, for their success, upon just the same principles of fair dealing which render successful arrangements as to wages, and if an even give and take does not exist, the maximum of success will not be secured.

A complexity of factors have apparently operated to place industrial medicine in the position in which it finds itself today. If we review the successive steps in the development of health legislation in England, it is not hard to realize — and this without making a brief for a working day of any standard length — that the procession of bills, which resulted in a steady betterment of working conditions from 1802 until 1878, have been economic life-savers for that country. The same truth applies to factory legislation in the United States. The permanent health of the working population can be and has been held fairly good through legislative enactment of varied type, and the regulations so established will continue to be of benefit as long as these nations endure.

There is a great difference, however, between the health conditions which are imposed through legislation and those which the employer and employee assume voluntarily. It is the latter which are creating interest today and which are the *raison d'être* of industrial medicine. We all recognize the eventual economic value of measures which regulate the work of women and children, and which forbid the existence of hazards such as every one knows have existed in the handling of lead, arsenic, and phosphorus. What we really want to know, however, is the extent to which group medicine pays in the factory, and this must not be in terms of intangible beliefs but it must be reduced to the coolest and surest of facts. The employer, as a rule, does not think of medicine as something which can be treated from a profit and loss point of view except in so far as the direct supervision of compensable

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cases is concerned. The idea that a well-trained industrial physician should be able to produce tangible results has never occurred to him. Medicine has always been a mysterious and unpleasant business which, so far as he has seen it intimately, must result in loss; and as a consequence he says, "Well, I suppose we've got to try it if every one else has started in," and thinks no more about the matter except to wish the costs of maintenance were not so great. Several reasons seem to operate to keep up this attitude on the part of the employer. One of these is the situation in which he very frequently places an intelligent and promising physician, making him but a cog in the machine of hiring and looking after men. The modern company, which at considerable expense secures a well-trained young chemist, realizes it gets but a poor return for this investment if the man in question has no chance to show his individual capacity and to bring to the company those infinitely valuable returns which imaginative work alone can secure. The chemist is placed in a laboratory with other chemists; and the fact that industry has fully realized the advantage of a sympathetic attitude toward their work is amply expressed in the daily achievements of the industrial chemists of this country.

If the industrial physician is a well-selected and well-trained man he must be given actual responsibility and opportunity to show in figures what his department can do. Such a result will never be attained without sympathetic executive oversight — the type of opportunity which the company is ready to accord to technical experts in other lines of work. Under such circumstances the physician should be able to show that his department justifies the outlay made for it, and if he fails in such a demonstration he has failed in his job. Frequently it happens that the medical department is given just such an opportunity as we have described, but nothing comes of it. We believe that a failure of this sort practically always arises from poor selection of the physician in charge of the department. A successful industrial physician must be a man who realizes that the vital function of industry is production, and that his task in the operations involved is to make production increase through safeguarding and improving the health of all those engaged in the work. In order to fulfill such a task, he requires a thorough knowledge of the best and most progressive practices in medicine, surgery, and hygiene, together with a sympathetic understanding of human beings. Such qualities are rarely combined. They certainly are not found in the unsuccessful general practitioner who takes a badly paid factory position as his last bulwark against disaster. Individuals of this type are doing much of the so-called industrial medicine in vogue today. The service they render, it may be fairly said, is just about commensurate with the pay they receive. From them the employer can expect nothing in the way of evidence indicating improved working capacity on the part of his force. The clumsy treatment of injuries and the administration of cathartics and adroitly exploited proprietary remedies represent quite fairly the limit of their capacity. The perspective of intelligently administered preventive medicine is one toward which they are hopelessly, permanently blind.

In order to prove to the employer and to the employee that industrial medicine is in reality an economic problem demanding the services of a well-paid and competent staff in whom every confidence may be placed, certain facts need to be made clear; and in some respects, as we shall indicate, these facts are not so convincing as they should and will be. The first of the facts is found in general evidence bearing upon the health of our working population. Recent experiences in the great war have been pro-

ductive of much material indicative of the working capacity of our young male population. Davenport and Love (1) have produced the first serviceable summary of the defects found in drafted men, and from their work we may gather data upon the omnipresence and importance of the health problem in industry. The total number of men involved in this study is about 2,500,000. In this total group 468 men were defective per 1000 examined; thus, almost half the men had some readily detectable physical or mental blemish. Davenport and Love summarize the defects found as shown in Table 1.

TABLE 1. — DISTRIBUTION OF DEFECTS IN DRAFTED MEN

	Per Cent.
Mechanical defects involving bones, joints, appendages, hands, and feet	39
Defects of the sense organs, eye, ear, etc.	12
Tuberculosis and venereal disease	11
Cardio-vascular diseases and defects	10
Defects of developmental and metabolic processes	10
Nervous and mental defects	6
Diseases of nose and throat	5
Diseases of skin and teeth	3
Diseases of respiratory organs other than tuberculosis	1
Other defects	3
Total	100

The first group of defects — mechanical defects involving bones, joints, appendages, hands, and feet — is of the most importance from the military point of view, but in some respects it is of equal importance in industrial medicine; thus, forty men in every 1000 had hernia. When grouped geographically Davenport and Love found the hernia incidence in the United States to be that shown in Table 2. In the light of this table, if the matter is viewed purely from the basis of just workmen's compensation, it is obvious, for example, that the New Jersey employer who does not have a medical department capable of making reliable examinations for hernia and of placing men so affected in properly supervised jobs, is running the risk of unjust demands for compensation. This statement becomes much more forcible when we realize that a far larger group with much wider age limits is employed by industry than is included in these draft statistics. It is

TABLE 2. — THE GEOGRAPHICAL INCIDENCE OF HERNIA AND ENLARGED INGUINAL RINGS IN THE UNITED STATES

Number per Thousand			
21–30	31–40	41–50	51–116
South Dakota	Washington	Montana	Oregon
Nebraska	North Dakota	Idaho	California
Kansas	New Mexico	Utah	Nevada
Missouri	Oklahoma	Colorado	Wyoming
Arkansas	Texas	Wisconsin	W. Virginia
Louisiana	Minnesota	Michigan	New Jersey
Kentucky	Iowa	New Hampshire	Florida
Tennessee	Illinois	Vermont	
No. Carolina	Indiana	New York	
So. Carolina	Ohio	Pennsylvania	
Maryland	Mississippi	Delaware	
	Alabama		
	Georgia		
	Rhode Island		
	Maine		

probable that the addition of these individuals increases rather than decreases hernia incidence. It is equally true that the workmen in New Jersey, in view of the hernia incidence which apparently exists among them, neglect their own interests if they fail to take advantage of intelligent medical supervision.

Another fact of prime importance industrially is the matter of tuberculosis. Davenport and Love (1) discuss this as follows:

> The highest incidence of this disease [tuberculosis] is in the desert states of Arizona and New Mexico and the adjacent states of Colorado and California. The reason for this is that the described area includes so many young men who have gone there because they are already victims of active tuberculosis. . . . The next most infected territories are the two northernmost Pacific states, the New England states and New York, and the group of states immediately south of the Mason and Dixon line, including also the states of Missouri, Louisiana, Mississippi and Georgia. New England has long

been known as a region with a high rate of tuberculosis, a disease whose fires are fed by the large number of recent immigrants. The states of Virginia, North Carolina, and Kentucky contain numerous sanatoria for the tubercular. The high rate in the Gulf states is probably due to the presence in them of a large proportion of negroes, as this race, particularly the mulatto, is especially susceptible to tuberculosis. The smallest amount of tuberculosis is found in the Great Plains region and the northern part of the Rocky Mountain range. This is an area occupied largely by non-British stock, which comprises exceptionally vigorous people. Tuberculosis in the rural southern states tends to overweigh the rate of tuberculosis in the rural population of the country as a whole. But in general, the agricultural areas of the north show less tuberculosis than the urban districts.

Here again the employer and the employee are informed of dangers which it will be to their benefit to meet fairly, and which the efficient industrial physician can more advantageously combat than any other single medical agent. Clark (2) places this question in the proper light when he says, "Tuberculosis, when arrested, is no bar to employment in a modern factory. Of course the work must be selected and the patient watched, but many cases will do moderately hard work for years without breaking down or exhibiting signs of activity. Active tuberculosis has no place in the factory." The employer must accept tuberculosis as a constant expense in his business, and, as in every other situation, this expense is not to be counteracted by neglect. Only through the maintenance of a medical department can tuberculous individuals be kept continuously employable. Laborer and employer alike must benefit from the modern attitude toward the situation.

In conclusion, Davenport and Love bring out such facts as the following:

> There are two great centers of defect — one is in the northeastern part of the United States, and the other in the western half, including especially the states on the Pacific coast and the two mountain states of Wyoming and Colorado. Of all states Rhode Island leads with a defect rate of 802 [per thousand]. This high defect rate, like that of the other New England states is largely controlled by flatfoot and hernia. In the case of Rhode Island, however, many minor defects find here the maximum or nearly the maximum ratio. Conditions in which Rhode Island stands first or second are: Alcoholism, obesity, neurosis, total for myopia and defective vision (cause not stated), hemorrhoids, bronchitis, deformities of appendages and trunk, atrophy of muscles of the extremities, underheight and underweight. The reason why Rhode Island stands at or near the top in many defects is largely because of the defective or non-resistant stock which has been drawn to this, the most urban of all states — that in which the population is most generally engaged in manufacturing. While one may not ascribe the defects to the occupation, it is probable that the relatively low-grade, ill-paid occupation has attracted a stock with inherent defects or susceptibility to disease.

Certainly both the workman and the employer have reason in Rhode Island to act positively and immediately in the organization of industrial medical departments. While we must realize that the draft figures which have been presented include many young men defective from a military point of view but vastly effective from the industrial point of view, we cannot get away from their insistence upon the necessity for health supervision in industry. A man with flatfoot is as completely disqualified for certain types of industrial work as he is for marching. A job which keeps him off his feet makes him as useful as his neighbor whose arches are normal. Medical supervision, which places men and women in work for which they are physically fitted, insures their future earning capacity and holds promise of increasing it, since failure from physical breakdown is lessened.

Let us turn now to further sources of evidence as to the health of our working population, drawing the material from industry itself. Emmet (3) has presented the most recent evidence available upon the number of days of disability experienced yearly by a group of 40,000 wage earners, practically

exclusively male. His figures list the disability experience of the Workmen's Sick and Death Benefit Fund of America. " The disability experience examined represents the average annual sickness for the five-year period ending December 31, 1916, and is, therefore, free from accidental variations, such as, for instance, those caused by the Spanish Influenza epidemic of last year." Nine days of disability per year has been the allotment made for the United States — assuming that our disability experience is parallel to that of Europe. Contrary to this estimate, 6.6 days per year were lost by the group of workers in question. Table 3 summarizes Emmet's findings upon this group.

TABLE 3. — AVERAGE ANNUAL NUMBER OF DISABILITY DAYS PER MEMBER AND DISABLED PERSON OF EACH CLASSIFIED FIVE-YEAR AGE GROUP

Age Group	Total No. of Disability Days	Total No. of Members Affected	Number of Disabled Persons	Average No. of Disability Days per	
				Member	Disabled Person
Under 20	2,108	406	127	5.2	16.6
20 to 24	34,296	7,168	1,778	4.8	19.3
25 to 29	76,619	15,267	3,574	5.0	21.4
30 to 34	106,162	21,886	4,862	4.9	21.8
35 to 39	155,209	27,496	6,197	5.6	25.0
40 to 44	196,206	30,746	7,104	6.4	27.6
45 to 49	206,860	31,579	7,150	6.6	28.9
50 to 54	189,850	25,484	6,044	7.4	31.4
55 to 59	146,777	16,229	4,168	9.0	35.2
60 to 64	80,459	6,689	1,859	12.0	43.3
65 to 69	25,361	1,843	557	13.8	45.5
70 and over	3,417	225	65	15.2	52.6
Total. . . .	1,223,324	185,018	43,485	6.6	28.1

It will be noted that the number of disability days increases progressively toward the higher age groups.

Forty-two industrial classes are represented among Emmet's 40,000 workers. Freight-handlers showed the largest average number of disability days, 9.7 a year. Miners came next with 9.1 days. Low in the list we find textile employees with less than the average number of disability days. No matter how one may view the figures, they portray a disastrous loss to the employer and to the employee. It is estimated that there are 25,000,000 industrial workers in the United States. If we multiply this figure by 6.6 we obtain 1,650,000,000 days of lost work in a year, a figure quite beyond our comprehension but if in error probably too small. It is unfortunately impossible to estimate the extent to which accidents and preventable disease, directly ascribable to industry and not to the home life of the individual, make up the 6.6 lost days. Nor can we, from these figures, obtain any reliable separation of accident disability and sickness disability. But the industrial life of the men making up this group represents at least one-third of the time involved in the study, and if but one-third of the disability of our working population is ascribable to their industrial existence, the economic loss involved should be a matter of concern for us all.

There are several routes of attack through which disability may be reduced. The actual prevention of accidents can accomplish much. With this work the medical department needs to keep in close touch, and that it does so is indicated in a recent study by Selby (4) who examined 118 establishments employing whole or part-time physicians. In twenty-eight of these the physicians accompany the safety inspectors on their regular rounds. Accident prevention has been largely an engineering and educational matter. There is evidence, however, that the overtired and subnormal worker operates with a careless disregard for the consequences to himself and to his fellows, which the healthy and normal worker does not readily display.

The extent to which disability from accidents may be reduced by a well-managed safety campaign is strikingly illustrated by Table 4 which gives the accident statistics

of the Commonwealth Steel Company for the years 1913 to 1918 (5). Instances of this type might be greatly multiplied but they are not directly related to the question of the economic value of the medical department in industry. The medical department contributes to the success they picture, but is by no means the sole source of it. The industrial physician does, however, enter the question of lost time from accidents upon the side of treatment. Can we present evidence that the period of disability is reduced through well-conducted treatment? The average industrial injury is slight, but owing to the desire of the workman to continue with his job, infection of untreated and unprotected injuries is practically certain to occur (6), and to infection we may ascribe much of the accident disability which causes economic loss both to the employee and to the employer. Clark (7), in 1917, records the fact that during the five years of operation of the medical department in the Norton Company of Worcester not a single case of sepsis has occurred. He remarks, "I do not feel that I can make the statement that we have never had a case of infection, for in several cases there has been a single drop of pus, or a moderate exudation from a wound. By sepsis I mean pain, heat, and redness accompanied by swelling. As we have been treating on an average of 241 accidents a month, it will be seen that the methods we use must be efficient." The crux of the treatment described rests in the fact that all injuries, however slight, reach the medical department within fifteen minutes, and before trouble has had a chance to start.

TABLE 4. — EFFECT OF SAFETY CAMPAIGN ON DISABILITY IN THE COMMONWEALTH STEEL COMPANY

Year	Deaths	Lost Time Cases	Compensation Cases	Compensation Received by Injured	Days Lost per Employee (Actual)
1913	2	800	330	$20,015	7.2
1914	1	414	168	8,138	4.2
1915	0	190	98	2,822	2.3
1916	0	769	223	7,638	2.6
1917	1	371	141	9,175	2.4
1918	0	124	57	4,391	0.6

Mock (8), reporting upon the same point in another large industry, says, "The number of infections following injuries has been reduced from 28.6 per cent. in 1912 to 7.57 per cent. in 1916. The time lost from infections in 1912 amounted to 1987 days, or an average of $2\frac{3}{5}$ days per case, while time loss from this cause in 1916 amounted to 816 days, or an average of $1\frac{1}{8}$ days. This was accomplished in spite of the fact that the working force had increased approximately one-fourth during the same period."

Another method of attack upon the economic loss reflected in the 6.6 days of disability which we have discussed, rests in the control of preventable illness by the medical department, and it is in this most important and useful phase of the work of the industrial physician that facts as to his efficacy are least available. Even if we make allowance for the fact that the task of demonstrating in figures that the medical department has reduced absenteeism from minor or major illness is a hard one, there is no excuse for the lack of existence of definite evidence upon the matter. We have begun to know what the standard causes of absenteeism from certain types of employment are, but our data are drawn from single industries and do not as yet represent the situation through industry as a whole. Thus Mock (8), in Table 5, presents a typical list of the diseases causing lost time for the Sears, Roebuck Company.

It should be possible to show that a well-managed medical department reduces the absenteeism arising from these causes, but as yet contributions showing that the industrial physician has accomplished this

end are not numerous. Lemon (9) speaks as follows in regard to the results attained by the medical department of the Milwaukee Electric Railway and Light Company:

> In the year 1915, also, the average sickness per man per year was reduced from eight days in 1913 to a little more than four days per man per year.
>
> We have in these combined results the summary of two factors: (1) a campaign of education, both within and without the company, for the prevention of accidents and (2) the result of a careful preliminary examination of employees, as well as a maintained high level of health incident to a very close supervision of the general health, by dividing the men employed into groups, in which they could be daily observed and in which the relief from the lesser ills which lead to greater could be had without delay.

Bardeen (10) has shown that the establishment of a medical department in the University of Wisconsin has produced results of a type which industrial physicians must also be gaining but which they have as yet failed to make public. He shows, for example, that naso-pharyngeal infections in which complications had developed decreased from 50 per cent. to 10 per cent., and that the average time lost from work decreased from eight and one-half to two and one-half days.

We have recently ascertained that in a large department store in Boston 40 per cent. of the absenteeism which can be classed as avoidable is due to illness. The physician undertaking such a task as this store presents should make it his business to show that gradually through proper attention to early cases and through proper measures as to health education and sanitation a great majority of the individuals formerly absent from work for minor causes are kept steadily at their tasks. It is true that a physician in a department store has not quite such a complete opportunity to control his patients as has the physician in charge of the students in a university, but his opportunity is much the same and his results ought to differ only in degree and not at all in kind.

The second way of determining the economic value of industrial medicine seems to us to be found in summarizing the opinions and actions of employers in regard to it. At the present time it is estimated that

TABLE 5. — DISEASES CAUSING TIME LOSS

	Number of Employees	Cases of Lost Time
Male	7,000	6,420
Female	5,000	15,244
Total	12,000	21,664

Minor Conditions	Female	Per Cent.	Male	Per Cent.
1. Headache	3778	24.0	1255	19.00
2. Dysmenorrhea	2935	18.9	...	...
3. Colds	2251	14.0	1313	20.40
4. "Grippe"	1354	08.0	956	14.80
5. Tonsillitis	974	06.0	883	13.70
6. Nausea	750	04.8	203	03.10
7. Other stomach conditions	403	02.6	331	05.00
8. Nervousness	355	02.3	42	00.60
9. Neuralgias, myalgias and pains in joints	188	01.3	123	01.90
10. Backache	153	01.0	111	01.80
11. Stiff neck	99	00.6	30	00.40
12. Eye conditions	172	01.2	56	00.87
13. Ear conditions	102	00.6	36	00.50
14. Fever	110	00.7	107	01.80
15. Diarrhea	130	00.8	74	01.10
16. Constipation	92	00.6	41	00.60
17. Fainting	132	00.8	13	00.20

Serious Conditions	Female	Per Cent.	Male	Per Cent.
18. Appendicitis	48	0.300	35	0.50
19. Bronchitis	27	0.180	45	0.60
20. Heart trouble	8	0.050	2	0.03
21. Kidney disease	4	0.020	4	0.06
22. Pleurisy	9	0.060	24	0.40
23. Pneumonia	2	0.010	12	0.20
24. Paralysis	1	0.007	1	0.01
25. Rheumatism	90	0.600	122	1.74
26. Anemic and generally run down	34	0.200	4	0.06
27. Acute contagious diseases	32	0.200	32	0.50
28. Typhoid fever	1	0.007	1	0.01
29. Tuberculosis	19	0.140	15	0.23
30. Miscellaneous	1281	8.400	505	7.80

there are 900 establishments in the United States, employing 1500 part-time and full-time physicians. This number increases constantly. There is no evidence that the employer, once a medical department is started, ever gives it up. He invariably enlarges its scope and improves the equipment, and this in spite of the fact that the cost of medical supervision is not light. Alexander (11), in 1916, found that the average cost of medical work per employee in ninety-nine establishments interrogated was $2.50. At the present time we know of two establishments where the cost is between $6 and $7 per employee, and there is certainly so disposition to curtail the service offered in either instance. It is probable that a figure of $5 per employee more nearly represents the average total cost of well-administered industrial medicine at the present time. There is no better evidence that industrial medicine pays than we find in this steady growth throughout the country. In it there is eloquent testimony of opinion of employers as to the value of the whole movement. Selby (4) has collected certain statements of employers giving their feeling upon this phase of the subject. He says:

Early in the study it was hoped that means for the valuation of industrial medical service could be found whereby definite limitations for expenditures could be justified, but such means could not be found. Employers are agreed that it has value, though they confess that the value for the most part is intangible and can not be expressed in terms of money. Failing in this, a different method was broached. "Why do you have a medical department?" responsible officials were asked.

"Purely for service," was the characteristic reply of one of the officers of the Ford Motor Co.

"We owe it to our men," said the superintendent of the Toledo Furnace Co.

"It is only human that we should take care of the men injured in our service," another answered, and he added with business acumen, "Constant expert medical service is insurance against big damages."

These and similar answers indicate that industry has a sense of its obligation toward the workers who become injured during employment. Another reason was brought out by other answers.

"It is a check on conditions that impair the health of our employees," testified the factory manager of the Willard Storage Battery Co. "It is just as necessary as a cost department, or any other non-producing department," he continued.

"To safeguard the health of the workers in the belief that the healthy worker is more efficient." The sincerity of this answer was supported by the fact that a modern machine shop had been moved by this concern in order to provide quarters for a department of industrial relations, with divisions of health, safety, and labor."

"Health education will reduce absenteeism 50 per cent.," was the surprising assertion of the superintendent of the National Lamp Works, Youngstown, Ohio, a successful employer of female labor.

"Instruction to the new men as they pass through the dispensary upon employment has reduced accidents by 50 per cent. in four months," was the equally surprising asseveration of the physician of a rubber establishment.

"It keeps the men on the job," was a frequent answer.

From these replies and others of similar import it may be gathered that industry believes medical service is capable of removing or minimizing certain causes of lost time.

A slightly different phase is represented in the following answer, which came from the director of safety and medical service for the White Motor Co. "Our medical department," he said, "has no responsibility beyond repairing damage done at work, though the doctor takes care of injuries not contracted at work and sickness, to keep men on the job. Men able to do light work, but not their regular work, are given light work on regular pay. We have a man with a bad heart — on the job by constant care of the doctor. We have a man 60 years old who had had rheumatism since a child; he couldn't get life insurance. We keep him on the job through the doctor's help, in order that he can get a house paid for." This firm, it is of interest to mention, had an annual labor turnover of only 60 per cent. at a time (Feb. 28, 1918) when labor was exceedingly restless and turnovers of 200 to 300 per cent. were not unusual.

In striking contrast to this was the situation in a large and rapidly growing establishment in the Middle West. Without quoting directly, it seemed, according to the officer interviewed, that this company provided excellent working conditions, with good lighting, etc., but having sixteen plants it was difficult for them to organize a central, or in fact any,

medical department. However, the number of accidents was very small, how many he was not able to say. The working force was stable. They had men who had been with them nine years, since the company was organized. They stabilized their labor by treating employees right. Everyone had access to the management, and employees were kindly disposed toward them. Yes, they had some turnover. They hired 31,000 people in 1917. He could think of no reason except labor conditions and sickness. He closed the interview with a remark which was to the effect that his company was satisfied with the conditions. Point is given to these utterances by the fact that this company had a labor turnover for the year of 1917 that was somewhat over 400 per cent.

It does not necessarily follow that the absence of a modern medical service from the executive organization of this establishment caused the high turnover of labor, nor does it necessarily follow from the previous quotation that medical service is the panacea for labor turnover, but there is sufficient reason in this and the expressions of other employers to warrant the conclusion that medical service is regarded as one of several activities that have been found to be of use in removing certain unstabilizing influences from employment. In this connection the particular services which medicine is able to render are: (a) The moderation of the effects of accidental injury; (b) the prevention of some varieties of sickness and the alleviation of others; (c) the definition of the physical limitations of employees in order that they may not be overworked; and (d) the promotion of a feeling of security among the employees by the manifestation of interest in their personal welfare.

A manufacturer who has developed a medical department of unusual scope and activity goes further than this in his pronunciation for industrial medical service.

" It is the point of contact between the head and the men," he said. " It promotes a feeling of good will toward the management. It has saved us a strike. It increases earning capacity by making the men regular and dependable. Wages have increased 68 per cent. in seven years and the cost of material has gone up, as you know, but our cost of production none."

Medical service according to him is able not only to assist in the stabilization of labor, but to increase its productivity as well. Others contributed to this opinion.

" Why do we have a dispensary ? " asked one, and he answered, " It pays."

" It's good business," said another, and he spoke for many.

A slightly different aspect is represented in the acknowledgment of the man who considers expert medical service to be a source of economy. " It saves us money," he replied, and confessed further, " It prevents litigation and keeps men on the job."

" It reduces our insurance cost," admitted another, in similar vein.

Expert medical service, according to these expressions, has proven to be good business, which indicates that it is profitable to industry, and an economical means of providing for the care of injured employees. More gratifying to the medical profession is the following reply:

" These measures (the activities of a proficient medical department) result in increased regularity and efficiency at work, reducing absence and alleviating pain, discomfort, and anxiety. In the minds of employees is created a sense of security, of confidence that they are working under the best possible conditions, that their physical welfare is being cared for, and that in accident or sickness proper attention will be provided. A healthier and more contented body of workers, with a higher industrial earning power, is the result."

Some employers were forced to provide medical service by reason of the locations of their establishments, others did so because it was " usual to such industries," and one was frank enough to concede that it was the insistence of his doctor that caused him to put in a medical department.

It appears from these expressions that industrial medical service is not a gift to labor, nor a charity, but purely a function of good business. The reasons which induce employers to provide their workers with medical service may be summarized as follows:

1. It is an acknowledgment of their obligation toward the workers who sustain injuries during employment and an economical means of procuring expert attention for them.
2. It is deemed capable of removing or minimizing certain causes of lost time.
3. It is one of several activities that have been found to be of use in removing certain unstabilizing influences from employment, and as such can be expected to assist in holding down the labor turnover.
4. It enables the workers to produce more.
5. It prevents litigation and reduces compensation expense.
6. It contributes to a sense of security among employees and promotes a feeling of good will toward the management.
7. Conditions make it imperative in isolated industrial establishments.

The third and last source of evidence as to the economic value of industrial medi-

cine is found in the attitude of the employee. The medical department cannot perform a one-sided function, and unless it is honestly of as much service to the employees as it is to the employer it must fail.

The attitude of labor is not hard to understand. Andrews (12), in 1916, wrote twenty leaders in labor organizations asking their opinion as to physical examination of entering employees. His replies without exception oppose it. Two of them are as follows, the first from an officer of the Iron Moulders' Union, the second from a California labor editor:

(1) In a general way I am most emphatically opposed to any physical examination of employees. Physical examination conducted under private auspices, that is, by physicians in the employer's hire, should not be tolerated for a moment.

(2) There seems to be an epidemic on among employers for the physical examination of employees. . . . These examinations are conducted more in the interests of profits than for the improvement of health conditions, and labor must insist that there shall be a well-defined limit to them until such time as ample provision shall have been made for the safeguarding of the health of the worker and caring for those excluded from the privilege of working because of the examinations.

The recent demand that physical examinations be abolished, made by the steel strikers, reflects the same feeling. Labor thus seems to distrust and deprecate one of the fundamental requirements of industrial medicine. But a view more consistent with progress (13) is found in the following quotation from the Committee on Welfare Work, of the Committee on Labor (Samuel Gompers, Chairman) of the Advisory Commission of the Council of National Defense, which was prompted to action in this regard by the need for greater consideration of the health of workers to maintain maximum production on war work.

It is the sense of this conference that the physical examination of workers is primarily a measure of health conservation and also essential to maximum production — a war necessity.

That the purpose of a medical examination is not to eliminate the worker from industrial service but to adapt him to the work he is physically fitted for.

THEREFORE BE IT RESOLVED, In view of the publicly announced policy of the government centralizing the recruiting of labor in the United States Employment Service, that this conference recommend that the medical examination of the workers be one of the functions of the government labor recruiting agency.

It further recommends the establishment of a central examination board, composed of representatives of the workers, employers, and the government.

That this board issue examination cards indicating the health of the workers and classify according to physical fitness.

Such a system of centralizing physical examination of workers does not prevent employers from maintaining their own system of physical examinations and follow-up methods for the purpose of conserving the health of their workers.

Mr. William Green, secretary-treasurer of the United Mine Workers of America, at the meeting of the International Association of Industrial Accident Boards and Commissions held in Washington in 1916, remarked:

In considering physical examination and medical supervision of employees it is all important that the primary purpose of said physical examination and medical supervision should be understood. If the primary purpose of physical examination is to promote the general welfare, to ascertain for what position the examined employee is best fitted, if it is for the purpose of building up the broken body or the diseased individual, then it certainly must be commended, because that is a praiseworthy purpose. If medical supervision is for the purpose of maintaining the physical standard of the employee at the highest possible point; if it is for the purpose of keeping him well and strong, of guarding and watching his health, then that is praiseworthy, and I know that the laboring people generally will have no objection to such physical examination and such medical supervision. But if the primary purpose of physical examination is to exclude the physically unfit, then the wage-earners are unalterably opposed to such physical examination. It would be inhuman and uncivilized to adopt a policy of ascertaining who the physically unfit were for the mere purpose of closing the door of opportunity to them. Even the savage would not do that, and surely in this twentieth-century, highly developed civilization we are not attempting to foster

a policy that is going to throw upon the scrap heap as helpless the physically unfit. They must be taken care of in some manner.

. . . Labor has no objection to physical examination or to medical supervision when the purpose of it all is praiseworthy, as I have stated, but they will oppose a policy that has for its purpose the exclusion of him who may be diseased or physically deformed.

We have not as yet discussed the saving to the employer which results from rejecting employees who are physically unfit. Mock (8, 14) covers this aspect of the economic utility of industrial medicine in considerable detail, and gives statistics which he collected from ten large industries having excellent medical staffs and basing their rejections upon reliable standards. Mock's figures are given in Table 6.

TABLE 6. — APPLICANTS EXAMINED AND APPLICANTS REJECTED BY THE MEDICAL STAFFS OF TEN INDUSTRIES

Item	Number	Per Cent.
Total number of applicants examined in one year	118,900	...
Total number employed having disabilities that did not interfere with selected work	41,158	34.7
Total number rejected for work because of disabilities	11,433	9.7
Total number having no disabilities of any moment	66,309	55.6
Total number of regular employees in those ten industries	102,400	...

It has been estimated that $35 represents the average cost of hiring and training a worker. Multiplying this figure by 11,433, Mock's number of rejected cases, there is a saving of $400,155 in labor turnover. It is just this saving which the employees distrust. They recognize that the mentally deficient and the man with active tuberculosis cannot be hired, but they fear that with the elimination of such as these go others upon less just grounds. The employer who possesses a thoroughly effective medical department will be able to show that his rejections for physical reasons are extremely few. Clark (15), speaking from his experience in the Norton Company, where the restrictive list of defects is rather severe because of the heavy nature of the work, finds that 3.5 per cent. of those applying for work are rejected on physical grounds. Howe (16) regards 10 per cent. as a normal figure for rejections and this coincides with the 9.7 per cent. found in Table 6. One cannot but feel that this figure is susceptible of reduction and that in any case the largest financial return from the medical department should not rest upon it. The employer must make his profit by fitting the physical conditions of the worker to his task, and to this principle labor has published no objection and through action has given every commendation.

Price (17) has given a brief account of the organization and methods of medical supervision in the garment trades in New York. Beginning in 1912 and until January 1, 1919, 27,640 medical examinations were made of garment workers in the medical clinic of the Joint Board of Sanitary Control. This board, in accordance with the agreement reached in 1910 following the strike in the cloak and skirt industry, consists of representatives from the public, from the employers, and from the garment trades union. It is most interesting that beginning in 1917 the clinic has examined every applicant for membership to the union, the unions having passed a law not to accept any candidates without a preliminary medical examination in the clinic.

All the work in the clinic is paid for by the labor organizations; the members themselves pay nothing except that those members who are not in good standing are charged a small fee for medical examination and treatment. An important extension of the work of the clinic is the nose, throat, eye and ear clinics, which are on a pay and co-operative basis. In other words, these clinics do not give gratuitous service but charge a nominal rate of $1 for eye, nose, throat, and ear examinations, by specialists. These special clinics are conducted at special times.

Another important extension of the activities of the clinic is the dental clinic. This clinic is a unique

establishment, in the fact that it is probably the first industrial co-operative, self-paying, dental clinic established, conducted, and managed by the workers themselves. The 27,000 examinations made in the medical clinic have clearly shown that a great many of the workers are suffering from defective teeth, and have likewise shown that a large number of these defects were directly contributory to various diseased conditions among these workers. Furthermore, it has been shown that the ordinary dental work which has been perpetrated upon the poor workers on the east side in New York City not only does not do them any good but does them real harm. Many of their dental defects are simply hidden and obscured by the gold crowns and bridges which are so lucrative to the dentists and so harmful to the patients.

The dental clinic is established to do thoroughly honest work in dentistry at a reasonable cost. The clinic employs a competent medical dentist who is doing good work and whose purpose is not so much curative as prophylactic. Educational work in prophylaxis is carried on all the time and is the main purpose of the clinic. All work is done in the clinic, which at present employs two full-time and two part-time dentists. During the year 1918, the dental clinic treated 7,465 patients, and has had an income of $12,576.73. It has practically paid for itself, although it had a slight deficit of $292. The charges to patients are based upon cost, approximately $2.50 being charged for an hour's work. Both the medical and dental clinics are very popular among the workers, and have proved successful in every respect.

The main significance of these clinics lies, of course, in the fact that they are conducted, financed, and managed by the workers themselves, for their own benefit.

Labor thus gives evidence of its appreciation of exactly the type of medical supervision which the employer has found worth while. What it objects to is the possibility that, if managed by the employer alone, medicine contains discriminative possibilities which may result in decided unfairness. The employer may rest assured that industrial medicine carried on by well-trained, forward-looking physicians cannot produce its greatest benefits for him unless it operates upon a completely impartial basis. It must not be "welfare work." It must not be a "finger wrapping" and compensation adjustment business. Medicine is something in which it is peculiarly easy to have faith, and the employer must have faith that the medical department in his factory is supplying him with healthy and efficient workmen through whom production will increase. The employee must have faith that the medical department exists for his interest to make him fit and to keep him fit, to see that his working life is prolonged and his earning capacity increased. It is the duty of the industrial physician to remove these faiths, translating them into facts through clear demonstrations of his part in advancing the productiveness and well-being of the whole organization.

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MEDICAL SUPERVISION IN FACTORIES*

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[This lecture was written with the needs of Great Britain in mind and without intimate knowledge of the development industrial medicine and surgery have undergone in the larger factories in the United States as described in Dr. Mock's monumental book. The conditions, and consequently the needs, in the two countries are not comparable and each will have to work out its own salvation independently of the other. The most notable difference between Great Britain and the United States as regards medical treatment of workers is the absence in the latter of a system of national insurance against sickness. The benefit of the National Health Insurance Act, to my mind, is that when any worker is found suffering from a condition requiring medical treatment, one can recommend the patient to go to his or her panel doctor and, knowing the standard of medical education in this country, feel that in the great majority of cases of illness reasonable treatment is obtained. While "reasonable" treatment is secured, it is not always the best obtainable, seeing that the National Health Insurance Act has not linked up treatment by the panel doctor with treatment in particular cases by specialists; nor is there as yet any return flow from the panel into the factory to reduce sickness there and thus reduce the claims which will otherwise ultimately be made. Legislation on both these points may confidently be expected before long under the newly constituted Ministry of Health.

The advantage I see in the direction industrial medicine has taken in America in the larger works is that the stimulus for its proper development and working comes from within the factory and is not imposed by the state from without; and, in a country where individualism counts for so much, it may be best. In Great Britain, however, it is doubtful whether workmen, organized as they are, would submit to a system which places them under medical supervision entirely under the control of the employer. I think it right that the employer should know the physical condition of those he employs, but this, in Great Britain, could best be secured by a part-time State Medical Service. One of the recommendations made at the International Labor Conference held at Washington in November last was that each member "which has not already done so should establish as soon as possible, not only a system of efficient factory inspection, but also in addition thereto a government service especially charged with the duty of safeguarding the health of the workers, which will keep in touch with the International Labor Office.]

NO book exists in the English language on the work of the factory surgeon.† This is remarkable, seeing that for a number of years some 2000 factory surgeons have been in existence. Every district in England must have its certifying factory surgeon, just as it must have its medical officer of health or surveyor. In Germany, on the other hand, there is not a single certifying surgeon, and beyond a few works surgeons in large chemical and other factories, and a few surgeons appointed to make periodical examinations in dangerous trades, only one or two medical inspectors of factories. But a book has been written there by Dr. Theodor Sommerfeld, called *The Factory Surgeon*. The book was published in 1906, with the object of assisting a movement for making medical knowledge an essential feature of factory administration in that country. Sommerfeld believes that a factory surgeon should be a medical man, well grounded in the practice of medicine, possessing also a knowledge of the special senses so as to make it unnecessary to call in a specialist immediately to determine, for instance, the effect of an injury to the eye, to the ear, or to the nervous system; he should, moreover, have special knowledge of public health work in its relation to factory premises, and have undergone a course of instruction at a university or technical

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† I retract this statement now and pay homage to *Industrial Medicine and Surgery*, by Dr. H. E. Mock, published since this lecture was delivered. — *T. M. L. April 27, 1920.*

school, in which industrial hygiene in its social, political, chemical, and physiological aspects had found a place. Such special knowledge cannot naturally be expected in the preparatory studies which a student of medicine must acquire, but it does fit in with postgraduate courses of study and particularly with those required for the diploma of public health.

The present duties of certifying surgeons, as laid down in the Factory Act and the Instructions of the Secretary of State, are briefly:

1. The granting or refusing of certificates of fitness within seven days of employment, for children and young persons under 16 years of age, or the qualifying of these certificates on the conditions and nature of the employment to which they may be put.
2. The reporting of cases of specified industrial diseases and poisonings.
3. Periodic examination of workpeople in certain dangerous trades under regulations or special rules.
4. Examination of those suffering from certain industrial diseases scheduled in Section 8 of the Workmen's Compensation Act, 1906, and the granting to them of certificates to enable them to claim compensation.

Of these duties, the one which is most before the certifying surgeon is the first, and it is important to bear in mind the limited character of the certificate which the law allows him to give, as misconception on the subject is great. The surgeon is merely asked to certify, after being satisfied as to the age of the child by the production of a certificate of birth or other sufficient evidence, that the child or young person has been personally examined by him, and is not incapacitated by disease or bodily infirmity from working daily for the time allowed by law. Observe the limited nature of the requirement without any words such as are found in the New York State labor law as to the child or young person's being "in sound health," which would make all the difference and enable a "hold" up to be effected until all remediable defects were remedied. If the child is able to walk up to the surgeon, showing that he is not halt or maimed or blind, if he can answer the surgeon's questions, showing that he is not deaf or dumb, and if the surgeon sees that the child is not obviously suffering from infectious or contagious disease, including pediculosis, he has difficulty in refusing a certificate.

Naturally, most surgeons do much more than this, and the following points are specified to be borne in mind when making an examination:

1. Auscultation of the heart, and presence or absence of anemia.
2. State of the glands in the neck.
3. Condition as regards tonsils and adenoids.
4. Condition of the teeth.
5. Infectious or contagious diseases including pediculi capitis.
6. Physical development.
7. Mental condition.
8. Hearing.
9. Sight.

There is a remarkable difference between a certifying surgeon's examination and that of a school medical officer. The object of the latter is to search out and make good the physical defects of the child while he is at school, so as to fit him for his work in the world. On the other hand, when the young person is presented or presents himself for a certificate of fitness, he is already starting on his life's work and is in the position of a bread winner, when many considerations may suggest themselves which make it undesirable to refuse a certificate. The wages he will earn may enable him to obtain better food, and so improve his general health. Again, if he be refused he may go round the corner to a workshop where the conditions may be much worse than in a factory, but there no certificate of fitness is required before employment.

I attach very little importance to the remarks of the lay person, whether manager, foreman, welfare supervisor, or factory inspector, who says that " the doctor just

looks at the child and signs his name," and that in consequence the examination is " a farce." These expressions of opinion fail to recognize how much is conveyed to the trained mind of the medical man from a superficial examination. Just as an agriculturist, travelling by train, is able to form a much better judgment of the productivity of the land over which he travels than an untrained person, so a physician from a brief inspection can make a much better judgment than a layman of the general physical condition of an individual. Still, the saying " Nothing for nothing, and very little for sixpence " is true, sixpence being the fee paid for a single examination; the minimum fee, including the examination of five persons, being 2/6.

The inherent defect, however, of the system has been a lack of any power to follow up and re-examine; this has interfered more than anything else with the usefulness of the examination. If there is a marked physical or mental defect, the candidate must be rejected. The surgeon has no power of saying " Let me see you in a month or two months' time." When once a young person has been refused, it is nobody's duty to see that the faulty conditions are remedied. The examination must be at the factory, unless fewer than five children or young persons are employed. Here, although there is opportunity of seeing the work to be done, facilities for examining are few.

Notwithstanding these objections I maintain that the value of the examinations has been very great. In the United Kingdom in 1913 the number examined was 529,491, and the number rejected 15,309, nearly 3 per cent. Of the 15,309 rejections, 10,797 (2 per cent.) were on medical grounds. These included: imperfect growth or impaired use of limbs, 564; defective sight or disease of eyes, 1,350; deafness, 290; mental defect, 89; disease of heart or lungs, 531; anemia or debility, 536; infection, 758; disease of skin, 468; want of cleanliness, 4,675; other medical reasons, 1,536. The remaining 4,512 rejections were: on account of age, 375; want of evidence of age, 3,460; other non-medical reasons, 677.

The surgeon has a useful power, given him in the 1901 act, of qualifying his certificate by conditions as to the work upon which the child or young person is fit to be employed. Indeed, certain associated conditions of infirmity and employment suggest themselves at once as undesirable, such as: (1) employment near machinery by workers with defective eyesight (monocular vision, errors of refraction), total deafness, mental defects and epilepsy; (2) the carrying of heavy weights by those suffering from anemia, and imperfect growth, lateral curvature, and heart disease; (3) work with poisonous substances by those affected with mental defect, or displaying obvious lack of cleanliness; (4) employment in processes involving dust by workers with weak chests.

Some certifying surgeons indeed have, in various industries, particularized the processes in detail, from the point of view of fitness for employment. But still the limiting conditions must refer to the work, and cannot be made to have personal application. Thus, there is no statutory power to attach the personal condition to " receive medical attention," or " wear suitable glasses," although the surgeon can, and naturally does, advise it. In a case of defective vision the surgeon can reject a candidate, saying that if the young person will present himself again with suitable glasses he will be passed, but the surgeon cannot pass the applicant on his promise to wear suitable glasses because he has no power of following the matter up. Any condition he can apply must refer to the nature of the work the young person of defective sight can engage on, such as, " not to work near machinery."

But listen to what one of the certifying surgeons in the East End of London does and has done, to my knowledge, for thirty years and more under these limited powers.

When I examine young persons *at the factory* I see them with the signs of their employment upon them, and as the occupier or his manager is usually present I can make enquiries and give certain instructions; for instance, in dusty trades I advise caps and overalls. I forbid girls who bite their nails to strip or handle moist tobacco, to handle lead, bronze powder, paint, poisonous drugs, or stains containing bichromate of potash. I forbid girls with loose hair to work on power machinery and I similarly restrict the employment of deaf persons. I forbid girls with obvious errors of refraction to do fine work without proper correcting glasses. I forbid girls with paralysed or deformed limbs to operate treadle machines. I forbid young persons of defective physique, healed tubercular joints or twisted spines to carry weights and restrict them to very light occupations. I also advise young persons suffering from non-infectious skin affections, septic mouths, etc. to submit themselves to hospital treatment and I suggest that the occupier shall be allowed to see the O. P. card so as to make sure that instructions have been obeyed. Some of my requirements are covered by the conditions affixed to the certificate of fitness, but this is in many cases insufficient inasmuch as I frequently recommend things not legally enforceable but I find that the occupier is almost invariably willing to follow my advice when its necessity is pointed out to him.

On the other hand, I find that young persons (particularly girls) attend for examination at my office *away from the factory* in their outdoor clothes and with no precise indication of their actual employment, of which indeed they are often ignorant. No responsible person attends with them to whom instructions can be given, moreover, many of the General Registers are badly kept and essential details are omitted so that considerable difficulties are unavoidable.

Young persons are now kept at school until the end of the term in which they attain the age of fourteen years; within the last week I have had a large number of such young persons to examine and I have been surprised at the number I found in a more or less verminous condition, which must have existed without detection during their school life. I think the school Doctor looks upon himself as rather above the school Nurse; anyway, I am certain that most school Medical Officers are utterly ignorant of trade processes and requirements, and unfitted to certify for Factory Employment.

The question arises: Why has there been this extraordinary limitation of the medical supervision of children and young persons in factories? To explain it we have to go back to 1833, when a certificate was first required from a surgeon or physician in the act to regulate the labor of children and young persons in the mills and factories of the United Kingdom. There were no birth certificates in those days, and the public conscience had been aroused by the excessively long hours worked by young children of 8 or 9 years of age. That act limited the age of employment in factories to 9 years and, in order that there might be some check on the employment of children less than 9, a certificate was required stating that each child had been personally examined or inspected, and that he or she was of the ordinary strength and appearance of a child of at least 9 years of age. So that it is clear no physical examination was in mind beyond that necessary to gauge the age. Later, in the act of 1844, it was still a question of age that was prominent, although by that time birth certification had been introduced. Certifying surgeons were required to make their examinations in the factory and not at their own houses. The fees were then fixed for this attestation of age but, in addition to the statement as to ordinary strength and appearance, the words "is not incapacitated by disease or bodily infirmity from working daily in the above named factory for the time allowed by this act" were further introduced.

Perhaps the most valuable work the surgeon has been able to effect has been the inculcation of the elementary principle of hygiene, i. e., cleanliness, by his steady rejection of uncleanliness of the head, which seems to baffle the efforts of school medical officers and teachers in elementary schools. We should not despise the day of small things.

The other duties of the certifying surgeon—namely, reporting on industrial disease, periodic examinations, and examinations under the workmen's compensation act—have been added by later acts and no one questions their value. Indeed, study of the reports on lead poisoning has been invaluable as showing the industries in which it is most frequent, the precise occupation in these industries where the workers run the greatest risk, and the fact that the cause of lead poisoning is, above all, the prevalence of dust and fumes. These duties, however, need not detain us now as there is no question of discontinuing them in future.

The time is ripe, however, for the reorganization of medical supervision in factories on wider lines than those which have been pursued hitherto. Undoubtedly, not less but more medical supervision is needed. As I conceive it, the future organization of medical supervision presupposes a medical inspector of factories in each division, who would act as liaison officer between headquarters, the divisional staff, and the factory surgeon.

The main duty of the factory surgeon should be, in my opinion, to bring his clinical knowledge to bear on the prevention of illness and injury from occupation, and to effect a cure, so far as possible, without absence from work. Too much, I think, has been expected from the certifying surgeon in the past, when asked to report on accidents caused by machinery. Many medical men are not interested in machinery, they have no technical knowledge of machinery, they have no technical training in the fencing of machinery. They were asked to report on a solitary accident and, when their report was made, all further concern on their part ceased. They ought not to be expected to be authorities on machinery accidents, or even on factory ventilation which is an expert matter and requires special training, nor on lighting, nor on heating. What they can do is to examine the chest, to examine the heart, and to say whether the person is physically fit for the work proposed for him. Only, in my opinion, when this is recognized, will the proper function of the medical man in the factory be performed. In order to bring this clinical knowledge to bear a surgeon should periodically visit the factory — how often, would depend on the size of the factory and the nature of the processes carried on. In works employing over 1,500 workers, his visits would probably take place at least daily, and in smaller factories at less frequent intervals but rarely less than once a month. If the occupier, as is likely in large factories, appoints a medical man approved by the medical inspector, arrangements might be made for attendance at least thrice a week for, say, two hours, and such provision should absolve the factory surgeon from any visit except for special inquiries.

The duties of the factory surgeon should be:

1. Initial detailed medical examination of all applicants for work, attaching, where necessary, conditional certificates either on personal grounds or as to the nature of the work on which the person is to be employed.

2. Re-examination of such persons as he considers need it, and power of inquiry, to see if previous conditional certificates have been observed.

3. Periodic medical examination, under Regulations and Special Rules, of workers in specified dangerous processes and in other processes, if so requested in writing by the medical inspector.

4. Periodic medical examination of the tuberculous, and of others (e. g., those with heart disease, disabled soldiers, etc.) affected with illness which, if not watched, might prove incapacitating, with power to specify the nature of the work upon which they may be employed.

5. Examination of cases referred to him by the welfare supervisor, and especially to advise in such cases as outbreaks of occupational dermatitis and the like, for which treatment could be prescribed.

6. Investigation of cases of poisoning, etc., notified under Section 73, 1901, and of cases prescribed under the Police Factories (Miscellaneous Provisions) Act, 1916.

7. Periodic inspection of the first-aid and ambulance equipment.

8. The making of such inquiries as may be required from time to time by the Secretary of State.

9. Performance of the duties required from the certifying surgeon by the Workmen's Compensation Act, with regard to certain industrial diseases.

Each one of these points deserves a lecture to itself, but here I can do no more than merely state them.

These duties do not include one examination specifically ordered, to comply with Section 64 of the Factory and Workshop Act, 1901, i. e., examination within seven days of employment. The young person will have been medically examined at school, and provision should be made to bring the result of the school medical officer's examination to the knowledge of the factory surgeon at his next periodic visit to the factory. Such a school certificate would take the place of the birth certificate, and might be of such a character that in country districts with few and unimportant factories the appointment of a factory surgeon would be altogether unnecessary. I am convinced, however, that in all industrial districts, a factory surgeon is essential, and that he should be independent of the local education authority.

What I have in mind in the factory is preventive medicine from the clinical side, that is, reduction of illness and inefficiency, and of their causes by medical or surgical supervision and treatment. The most suitable person, in my opinion, to give this treatment is the type of person now appointed as certifying surgeon — a man in general practice or a consultant, who knows the home conditions and treats the workers in his own surgery and is alive to advances in medical and surgical knowledge.

My objection to the whole-time medical officer of health (or an assistant medical officer of health, combining the duties of school medical officer, as would necessarily have to be done, in view of the amount of work) is that he is not in touch with clinical medicine, often does not live in the district, is not brought into intimate contact with the workers as patients in their own homes, is usually a man freshly qualified, intending only to remain until he can get a more remunerative post, and appointed by and subject to either the public health or education committee. Nothing in this conflicts in the least with the useful work the school medical officer would do in examining, *in continuation schools*, young persons up to the age of 18, with a view to rectifying physical defects.

I should like to see the works surgeon a unit connecting the Factory Department with the National Health Insurance Commission, so as to diminish the amount of the claims on the insurance funds by preventive clinical supervision in the factory. I do not see how, under this scheme, the factory surgeon can possibly be paid for his duties in the way he is now, i. e., by small fees from the occupier for each service rendered, after the reception of which all his responsibility ceases. Such a procedure cuts at the root of all following up. I should prefer to see the factory surgeon a part-time state salaried officer, on the lines suggested in the Cavendish lecture on "The Future of the Medical Profession" by Sir Bertrand Dawson in the *British Medical Journal* of July 13, 1919. I am glad to see how favorably such part-time service, properly controlled, is regarded in the United States. Seeing that the whole scheme is drawn up in the interests of industry, it would be right that the expense in carrying it out should ultimately be a tax on industry. Occupiers might be expected to pay an annual sum, dependent on the size of the factory, out of which the salary of the factory surgeon would be paid.

THE PHARMACOLOGY OF HEAVY METALS*

WILLIAM SALANT, M.D.

THE behavior of heavy metals has long been the subject of inquiry by pharmacologists and toxicologists—inquiry resulting in the growth of an extensive literature on the subject. Indeed, a bibliography of the action of heavy metals would fill many pages including such investigations as their manner of absorption, their fate in the body, their effects on metabolism and their influence on different organs. There is, nevertheless, a striking paucity of data concerning the action of some of the heavy metals, while the behavior of others in the body is scarcely known. This is true notwithstanding the fact that many cases of poisoning have occurred as a result of presence of these metals in food products and notwithstanding the fact that a number of them are known to play an important rôle in industrial hygiene.

The extent to which some of the heavy metals are present in food products is indicated in the following reports. According to analyses published recently by Bircknер (1) the quantity of zinc in oysters may reach 1.15 gm. per kilo, in baker's yeast 0.414 gm. per kilo. Dried eggs, according to analyses made in the Bureau of Chemistry, may contain as much as 2.4 gm. per kilo; while Hiltner and Wichmann (2) reported 2.9 gm. of zinc per kilo in oysters. The results of similar analyses for copper are also interesting. The quantities in oysters varied between 52 and 539 mg. per kilo, but in one instance, with drained oysters, 1487 mg. per kilo were found. According to Leach (3), from traces up to 2.75 gm. of copper per can were found in canned vegetables. The same writer states that the quantity of tin in canned vegetables may amount to about a third of a gram per kilo. According to Harrington (4), 0.25 gm. of nickel sulphate may be present in green peas. Tin has been found in a number of foods in amounts of 10 to 450 mg. per kilo, the quantity even reaching so high a figure per kilo as 1.5 gm. Lead also is present in very small quantities but in view of the clinical and experimental evidence concerning this metal, as shown by the work of Straub (5), Erlenmeyer (6), Legge and Goadby (7), and Oliver (8), very small doses cannot be considered safe when taken into the body habitually — a contingency which must occur if it is present in foods.

The effect of heavy metals on health is therefore a matter of prime importance — a fact which emphasizes the need for more extensive investigation — for only by obtaining incontestable evidence of their poisonous effects can preventive methods be adopted. But a better understanding of the action of heavy metals is needed in other connections. Heavy metals are also known to cause injurious effects of a serious character in persons exposed daily and for years to their action in many important industries. It is well known that lead poisoning occurs in a large number of trades. Oliver (8), Legge and Goadby (7) in England, and Alice Hamilton (9) in this country, who have for years been directing attention to industrial lead poisoning, state that lead is employed in about 150 industries. Zinc is also known to be an important etiological factor in the causation of certain industrial diseases. The symptoms of poisoning observed in braziers and brassworkers may be mentioned as some of the abnormal changes produced by this metal. Copper is not commonly considered an industrial poison, but according to Hayhurst (10) its astringent and caustic salts

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may produce contact poisoning in workers handling them. Cases of poisoning with manganese have been reported within recent years by several observers. Casamajor (11) reported ten cases with peculiar neurological symptoms and a number of cases have been described by Emden (12), by von Jaksch (13), and very recently by Edsall and his collaborators (14). Nickel in metallic form was considered to be without toxic effect, but experiments carried out by Armit (15) indicate that it is by no means free from poisonous properties. This is especially the case when nickel is in combination with carbon monoxide forming nickel carbonyl, the fumes of which when inhaled produce serious and even fatal symptoms. The effect, according to Armit, is not due to the carbon monoxide present but to nickel in the form of a slightly soluble compound or in a fine state of subdivision. Other heavy metals, such as mercury and certain compounds of iron, vanadium and chromium may also be mentioned in this connection as causative agents in the production of occupational diseases.

Further and wholly different reasons from these suggest also the need of further inquiry into the mode of action of heavy metals. In the absence of accurate information on this subject, federal and state officials may, and sometimes do, impose unnecessary restrictions on the manufacture and sale of various food products, leading to unnecessary waste of foodstuffs and to needless disturbance of important industries with consequent economic loss, which in these days of the high cost of living is a matter for serious consideration.

To aid in safeguarding the public health and in preventing economic losses to the community and to the individual, the writer several years ago planned extensive investigations into the action of heavy metals. Some of the substances in question have already been studied by him and his collaborators, but much more remains to be done. Owing to circumstances over which he had no control, the work was interrupted, but the writer hopes to resume these urgently needed investigations. Meanwhile, preliminary observations on the subject are presented in the following report.

Experiments with Zinc

Zinc in our experiments was given to different animals, usually in the form of malate but sometimes as the chloride. The salts were fed to animals in their food and tests were made of the effects on different organs. The feeding experiments were carried out on rats for periods of two to four months, and on cats for from ten days to two months. No effects were noticed on the general health, although considerable quantities of the metal were given, much more than could possibly be taken with food by a human being in the course of a day. Rats weighing 150 to 200 gm. which received 10 to 15 mg. of zinc acetate daily for four months kept their weight, though in some cases there seemed to be some disturbance of renal function. Cats received daily 50 mg. of zinc in the form of malate. Some of them gained in weight 23 to 26 per cent.; one cat gained 4 per cent.; three cats showed a loss of 3 to 5 per cent. The literature on this subject shows contradictory results. According to Sacher (16), amounts up to 34 mg. of zinc per kilo given daily in their food to rabbits for from five to thirty days proved harmful, and 6 to 28 mg. proved harmful to cats. Sacher reported loss of appetite, albuminuria, congestion of the kidney, and hemorrhage into the gastric mucosa. On the other hand, it was reported by Lehmann (17) that 0.5 gm. of zinc per day, fed daily for 242 days, failed to cause any untoward effects. Brandl and Scherpe (18) fed various amounts of zinc salts to different animals. Dogs, rabbits, and guinea pigs which received daily 1 to 2

mg. of zinc as malate for seventy-seven to eighty days failed to show any effects. Young dogs that were fed 8 to 9 mg. daily for 127 days continued to grow and gain weight. In another experiment on two dogs, increasing doses of zinc were administered for fifteen days until in one case a dose of 420 mg. of zinc per kilo was given, but no symptoms of injurious action of the metal were observed. Rabbits, however, seemed to be less resistant. Up to 8 mg. per day were borne without any apparent injury, but when the dose was increased to 437 mg. per kilo daily and given for some time, there was loss of appetite and albuminuria. On autopsy the kidneys were found congested and showed the presence of cloudy swelling; there was also hemorrhage into the mucous membrane of the stomach.

Although the action of zinc when taken by mouth, even in comparatively large amounts, is not very injurious, the case is quite different when zinc is introduced directly into the circulation and comes in contact with various organs. The writer and Miss Connet (unpublished experiments) have shown that when a nutrient solution to which a small quantity of zinc is added is perfused through the isolated frog heart, a change in its activity is at once noticed. Heart action becomes weak, the amplitude becomes visibly smaller with each beat, and the action becomes irregular, auricles and ventricles ceasing to work in harmony. This may go on as long as the heart is exposed to the solution; not infrequently the change caused by the zinc may continue even after the perfusion has been discontinued. A second treatment, after a considerable interval of time, produces more marked effects, thus suggesting cumulative action. In heart-perfusion experiments, carried out by me with the collaboration of Miss Connet, with a solution of 1:50,000 of zinc malate in Ringer's solution or one part of zinc to about 200,000, one minute was sufficient time to produce very marked cardiac depression. The injury to the heart was very striking when stronger solutions of zinc malate were used. One-twenty-fifth of 1 per cent. caused depression of heart action which tended to be permanent, while in other cases recovery was very slow. With a concentration of 1:1000 of zinc malate in Ringer's solution, permanent arrest of the heart was observed.

The depressing effect of zinc is not confined, however, to the heart. Mitchell and I (19) carried out experiments with zinc salts on different animals and found that smooth muscle is likewise affected by zinc. Segments of the intestines, a few centimeters long, removed from animals under deep anesthesia and suspended in Locke's solution, ceased their movements when a sufficient amount of zinc malate was added. A solution of N/2000 of zinc malate produced a very distinct diminution in the force of rhythmic contraction, and when the concentration of zinc was doubled the contractions became very weak and irregular at the end of forty-five or fifty minutes. When the solution containing zinc was removed and another solution without zinc substituted, there was only partial recovery of function. When the amount of zinc was increased still more, there was complete abolition of function, which in some cases was permanent.

That zinc is a general protoplasmic poison is further indicated by the fact that it has a decided influence on other organs than the heart. According to Harnack (20) zinc caused in higher animals symptoms of nervous depression, muscular paralysis, and paralysis of respiration and of the circulation. According to the observations of several investigators, zinc, like some of the other metals such as mercury, uranium and chromium, may produce serious injury to the kidney. This, as shown by D'Amore, Falcone and Marmaldi (21) may be associated with glycosuria. Recently Dr. Wise and I (22) carried out experiments with

zinc malate. We found that a gram of zinc malate fed to animals may be followed by albuminuria. The effect was more constant and the damage more pronounced if a small quantity of zinc was introduced directly into the circulation. Ten mg. of zinc per kilo injected intravenously caused very marked injury to the kidney; a large amount of albumin and many casts were present in the urine. In a large proportion of cases death occurred within a few days. Associated with these renal changes was the presence of sugar in the urine as well as an increased concentration of sugar in the blood, amounting at times to 30 or 35 per cent. The amount of sugar in the urine of rabbits did not exceed 0.3 per cent., but in cats it reached 2.75 per cent. after subcutaneous injections. Glycosuria was also observed in dogs after subcutaneous injections of zinc salts, but the quantity was less than in the urine of cats.

The elimination of zinc after it reaches the circulation has been studied by several workers, the results obtained being somewhat contradictory. In co-operation with Rieger and Treuthardt (23), I was able to obtain interesting data on this subject. We found that zinc is absorbed from the intestine and that the intestinal canal is also the main channel of elimination, the kidney playing a very subordinate rôle in ridding the body of the metal. No zinc was found in the stomach of animals which received zinc salts intravenously. A study of its distribution in the body indicated that it was stored up in considerable amounts in the liver; it was almost always found in the skin and in the muscles, but none was present in the brain.

Experiments with Tin

Another metal which is of frequent occurrence in foods is tin. The enormous development of the canning industry makes it particularly desirable that accurate information regarding the physiological effects of tin should be obtained. I carried out feeding experiments with the tartrate and chloride on cats, administering daily 10 to 50 mg. of tin in the form of these salts, mixed with the food of the animals. Ten mg. of tin per kilo, fed for twenty-three days and followed by 20 mg. per kilo for three months failed to show any harmful effects. There was, on the contrary, a gain in weight of 100 to 400 gm. But when the dose was increased to 30 mg. per kilo and fed for about two and a half months there was a loss of weight amounting to $10\frac{1}{2}$ per cent. in two cats. The decrease was much faster in these two cases when the dose was increased to 50 mg. of tin per kilo. At the end of four weeks' feeding of such a dose, the loss in weight of one cat amounted to 10 per cent.; in the other it was 16 per cent. Three other cats similarly treated were more resistant, as they lost only 5 per cent. of their weight during the four weeks. But a sixth cat which weighed 1400 gm. lost 450 gm. and died at the end of the period. It is evident, therefore, that moderately large amounts of tin given daily with food for fairly long periods may prove harmful to health. It might be added that the chloride of tin is probably more injurious than the tartrate, since the marked emaciation occurred in the cat which received the chloride. It is possible, however, that the decreased resistance to tin was due to some abnormal condition in this cat, since two other cats belonging to the same series of experiments received the same amounts of tin chloride and survived with a loss of weight amounting to only 5 per cent.

Rieger, Treuthardt and I (24) also studied the fate of tin in animals. After the subcutaneous injection of some of its salts, the metal was present in the urine and in the contents of the stomach and of the intestine. Smaller amounts, however, were eliminated by the kidneys than by the intestines, tin resembling zinc in this respect. It is of interest to note that the rate of

excretion of these two metals was somewhat different, the amount of tin excreted by the kidney being greater than that of zinc. In some experiments almost as much tin was eliminated by the kidneys as by the intestines, but this was never the case with zinc. That tin is very slowly absorbed from the intestines was shown by the fact that after feeding considerable quantities daily and for weeks, very small amounts only were found in the urine. This is not at all surprising in view of the fact that the salts of tin are so insoluble. When they are fed for a long time, however, absorption may take place, for small quantities were recovered from animals that had received the tartrate for from three to four months. It is quite probable that after tin has been fed for a certain time changes in the mucosa occur which increase its permeability to the metal. This is supported by observations by Buchanan and Schryver (25), who detected tin in the urine of dogs during the second and third weeks of the feeding of tin salts, but not during the first week of the experiment.

The results of experiments carried out on other heavy metals are of interest in this connection. Miss Connet and I (unpublished results) made a number of tests with copper sulphate on the isolated heart of the frog. A solution of 1:10,000 produced prompt depression of cardiac action. At the end of one minute's exposure to the salts, the heart became very feeble and remained permanently in this condition. Much more pronounced was the effect of cadmium. A solution of 1:1,000,000 of the acetate in Ringer's solution caused a very noticeable diminution in the force of the heart, without changing the rate to any appreciable extent. A solution of 1:100,000 produced about the same effect as a concentration of copper sulphate that was ten times as strong.

Experiments with nickel acetate were made on the heart as well as on the isolated intestine. The effects were different from those obtained with the other heavy metals. When the frog heart was perfused with 1:10,000 nickel acetate in Ringer's solution, the contractions became less frequent but more forcible, and recovery occurred after perfusion with nickel acetate was discontinued. A more detailed study of the influence of nickel, copper, cadmium, and zinc on the isolated heart will appear shortly in the *Journal of Pharmacology and Experimental Therapeutics*. The report will also include experiments with cobalt, iron, manganese and uranium. The reaction of the isolated intestine to nickel acetate, which was studied by Mitchell and myself (19), indicated a very pronounced depression with strong solutions only. Weak solutions caused primary depression followed by stimulation.

Of the other heavy metals to which attention might be called, lead is the most toxic. Straub and his pupil, Erlenmeyer, have shown that less than 1 mg. of lead per kilo when present in the circulation is sufficient to cause bulbar paralysis in cats within sixty days. In experiments on the isolated intestines of animals the writer and Levine (unpublished experiments) found that small quantities are markedly toxic, which is particularly interesting in view of the fact that lead has been shown to be present in small quantities in certain food products. Baking powder contains about 10 mg. of lead per kilo, but it is doubtful if even this amount should be permitted in articles intended for human consumption. According to Professor Rubner and Dr. Smith, 0.36 mg. of lead is the minimum of safety quoted by Oliver. According to Oliver (8), 0.2 to 1.5 mg. of lead in a liter of water cause lead poisoning when taken for several months. A note of warning may therefore be sounded to those who are in a position to decide whether the public should be permitted to use food products that contain any lead at all.

In conclusion, it may be pointed out that some of the heavy metals considered are very poisonous, producing degenerative changes in some organs and causing functional disturbances in others. At the same time it is necessary to recognize the very important fact that the heavy metals are apparently well borne for a considerable length of time when taken with food. At least no injurious effects can be traced to their ingestion, which indicates that the intestinal canal probably exerts a protective action against the poisonous action of these metals and their salts. It is necessary to bear in mind, however, that disturbance of function of the intestinal canal or structural changes of the mucous membranes of the stomach and intestines may occur, in which case the protective action of these organs may cease and the metals may thus gain access to the different organs causing serious and even irreparable damage. It is advisable, therefore, that notwithstanding the apparent harmlessness of some of the heavy metals when taken with foods, caution should be exercised in permitting the manufacture and sale for human consumption of foods containing even small amounts of such metals. The public is entitled to the benefit of the doubt in the case of those metals, the harmlessness of which has not been firmly established.

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Vienna, 5. March 1920..

Dear Sir,

Will you kindly exeuse, if we the members of the Viennese factory-inspection ask of you as our American colleagues the favour to send us through the newly established »American Relief Action« (Ware-Houses) some parcels containing different artieles of food.

The shortness of provisions in Vienna is now beyond all description and we certainly would not dare to appeal to you for assistance if the famine had not already undermined the health of our families and especially of our children.. To the Viennese factory-inspection belong now 23 gentlemen- and 3 ladies-inspectors, besides 14 assistant clerks..

Please believe us that we immediately will repay our debts as soon as the value of our money will rise.. Until then we would be glad to be of use to you.. Perhaps we could contribute to your American special magazines and journals some essays about technical, hygienieal or sozial questions. Let us kindly know in which of these topics you would take most interest..

Please send your answer to the following address:

m/ Gewerbe-Oberinspektor Karl Hausk, Vienna,. I.. Hofgartenstrasse 3,

Austria, (Staatsamt für soziale Verwaltung).

Believe me, dear Sir,. to be

very truly yours

Wird hiemit befürwortet!

Wien, am 6. März 1920.

Der Hofrat
Central-Fabriks-Inspektor:

We warmly recommend this request

Vienna, 6th March 1920.

Chief-Factory-Inspector.

APPEAL FOR FOOD FROM THE FACTORY INSPECTORS OF VIENNA

At the request of Dr. George M. Price, Director of the Joint Board of Sanitary Control in the Cloak, Suit and Skirt and the Dress and Waist Industries, we are glad to reproduce the preceding appeal for food, received by Dr. Price from the members of the Viennese factory-inspection service. Dr. Price writes, "I am sending you herewith an appeal which I have received from Vienna from some of the inspectors I have known when I visited there. I have done all I could personally and have also induced the New York State Industrial Commission to make an appeal, and it seems to me it would be well to have this printed in your Journal, as well as to make arrangements for some contributions from these highly competent authorities." The preceding page contains a photographic reproduction of the letter received by Dr. Price.

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

The Medical Aspects of Mustard Gas Poisoning. By Aldred Scott Warthin, Ph.D., M.D., Professor of Pathology and Director of the Pathological Laboratories of the University of Michigan, Ann Arbor, Michigan; and Carl Vernon Weller, M.S., M.D., Assistant Professor of Pathology, University of Michigan. Cloth. Pp. 267 with illustrations, bibliography and index. St. Louis: C. V. Mosby Company, 1919.

Teaching the Sick. A Manual of Occupational Therapy and Re-education. By George Edward Barton, A.I.A., Director of Consolation House and President Consolation House Convalescent Club, Inc. Cloth. Pp. 163 with illustrations and index. Philadelphia: W. B. Saunders Company, 1919.

The Narcotic Drug Problem. By Ernest S. Bishop, M.D., F.A.C.P., Clinical Professor of Medicine, New York Polyclinic Medical School; Member Narcotic Committee, Conference of Judges and Justices of New York State; Committee on Habit Forming Drugs, Section on Food and Drugs, American Public Health Association, etc. Pp. 165 with appendix and index. New York: The Macmillan Company, 1920.

The Labor Situation in Great Britain and France. By the Commission on Foreign Inquiry of the National Civic Federation, 1919. Cloth. Pp. 433 with index. New York: E. P. Dutton & Company, 1919.